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MADRAS GOVERNMENT MUSEUM

GUIDE
TO THE
INVERTEBRATE GALLERIES

BY

S. T. SATYAMURTI, M.A., D.SC., F.Z.S.
Director of Museums, Government Museum, Madras

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GUIDE TO THE INVERTEBRATE GALLERIES

INTRODUCTION.

The Invertebrate Galleries of the Madras Government Museum are accommodated in two halls on the first floor of the rear building, directly above the Reptile and Bird Galleries. The first hall is a comparatively narrow, oblong one and contains exhibits peratining to the lower groups of invertebrates, such as the very simple, unicellular, microsopic animals (*Protozoa*), sponges (*Porifera*), corals, sea anemones, jellyfishes, etc. (*Coelenterata*), flat-worms, round worms, etc. (*Platyhelminthes*, *Nematoda*, etc.), segmented worms (*Annelida*), and a host of other miscellaneous groups including the minor phyla, while the adjoining much larger and more or less square hall is devoted to the higher groups of invertebrates, comprising three of the major phyla, namely, the Mollusca, Echinodermata and Arthropoda.

The invertebrates or animals without a skeleton of bone or cartilage include several heterogeneous groups differing from each other radically in structure and appearance. They also range in size from microscopic animalcules to gigantic forms such as the giant squids measuring nearly fifty feet in length, or enormous masses of coral weighing several tons.

According to the most recent system of classification, the animal kingdom is divided into two main subkingdoms—the Protozoa comprising the unicellular animals and the Metazoa including the multicellular or tissue-bearing animals, comprising all the remaining groups of animals. The subkingdom Protozoa includes only a single phylum, the Protozoa, while the subkingdom Metazoa includes all other phyla.

Most of the better known and more important among the main groups or phyla of invertebrate animals are representated by exhibits in these galleries, either in the form of actual specimens (wet or dry-preserved or in the form of models (mostly enlarged), charts, diagrams or photographs. Those phyla which are represented by exhibits in these two galleries are listed below, more or less in their proper systematic sequence, together with a brief note on the main characteristic features of each group, and it is hoped that the following synopsis will serve as a helpful introduction to the vast assemblage of widely differing groups of animals that are exhibited in these galleries.

HALL I.—LOWER INVERTEBRATES

SUBKINGDOM PROTOZOA.

Phylum PROTOZOA ..	Includes the Protozoans or unicelluar animals. Each individual animal is one-celled or is in the form of colonies of similar cells. No tissues are formed. They are generally microscopic.

SUBKINGDOM METAZOA.

Phylum MESOZOA ..	These are small, slender, primitive, worm-like, solid, multicellular animals. Their bodies contain an external layer of ciliated digestive cells, surrounding one or several reproductive cells; they are parasitic in octopuses and other invertebrate animals.
Phylum PORIFERA ..	The sponges. They exhibit radial symmetry and thier bodies are cylindrical, globose, branching or irregular. They possess an internal skeleton composed of minute spicules or of horny fibres. The surface bears many pores leading into a system of canals and chambers lined by flagellated collar cells. They are all aquatic animals and are sedentary.
Phylum COELENTERATA (=CNIDARIA)	Radially symmetrical animals; the individual consists of a cylindrical cup-shaped structure attached to some substratum, often in colonies, or a bell-like free-swimming medusa with much gelatinous material (mesoglea); stinging cells (nematocysts) are present. The mouth is surrounded by tentacles. The animal lacks an anus and head. All are aquatic, mostly marine.

Phylum CTENOPHORA ..	The Comb-jellies. They exhibit biradial symmetry; the body is subspherical, with much gelatinous substance (mesoglea) or flattened. Eight rows of ciliated comb plates are present for locomotion. Nematocysts (stinging cells) are absent. The digestive cavity bears branched canals. There is no anus. They are all marine, solitary and free-swimming.
Phylum PLATYHELMINTHES.	Flatworms. The body is depressed, thin, soft and leaf-shaped or ribbon-like. The digestive canal is branched and devoid of an anus, or is absent altogether. A sort of tissue (parenchyma) fills the spaces in between the organs. They are generally hermaphroditic (i.e.), both sexes are represented in the same individual.
Phylum NEMERTINEA ..	Ribbon worms, The body is slender, soft and very elastic, and covered with cilia, and is unsegmented. The mouth is anterior, with a long, eversible proboscis. These are free-living worms, mostly marine.
Phylum ASCHELMINTHES..	Animals of small or minute size, with the body usually slender and with a complete digestive tract; the intestine in usually straight, with the anus situated posteriorly. This phylum includes a number of minor groups, such as Rotifera, Gastrotricha, Kinorhyncha and Nematoda which were formerly treated as distinct phyla, but are now regarded as classes under the Phylum Aschelminthes.

Phylum	ACANTHOCEPHALA.	Spiny-headed worms. The adults live as parasites in the intestines of vertebrates. The body is flat and rough in the living condition, but smooth and cylindrical when preserved. The front end bears a retractile proboscis bearing rows of recurved hooks. There is no alimentary canal.
Phylum	ANNELIDA ..	Includes the segmented worms The body is elongated, usually composed of many similar segments, with fine. bristle-like setae for locomotion. The digestive tract is complete and tubular. There is a well defined nervous system composed of a dorsal brain and a ventral nerve cord, having ganglia and lateral nerves in each somite. These are mostly free living worms.
Phylum	SIPUNCULOIDEA.	Peanut worms. The body is slender, tubular and highly contractile. The slender anterior end is retractile, with short, hollow tentacles around the month. The body is unsegmented and setae are absent. The digestive tract is slender and spirally coiled. They are marine. The sexes are separate.
Phylum	BRYOZOA (=POLYZOA).	Moss animals. They occur in colonies, branched and plant-like, or as low incrustations on rocks or shells, or as gelatinous masses. The colonies consist of numerous minute individuals each housed in a separate compartment (zooecium). The mouth is surrounded by ciliated tentacles. The digestive tract is U-shaped and complete. These animals are free living and inhabit both salt and freshwaters.

Phylum PHORONIDEA	The body is worm-like, cylindrical and unsegmented, encased in a membranous tube; the anterior end bears ciliated tentacles and a horse-shoe-shaped structure, the lophophore; the digestive tract is complete, with the mouth and the anus placed within the lophophore. They are marine animals and are hermaphroditic.
Phylum CHAETOGNATHA.	Arrow worms. These are small, slender, transparent, with the body consisting of a head, trunk and tail; and with bristles or hooks about the mouth; the body bears paired fins and a terminal tail fin for locomotion. The digestive tract is complete. They are free-living, marine animals.
Phylum BRACHIOPODA	Lamp shells. They bear an external calcareous shell composed of a dorsal and ventral valve. They are attached to rocks by a fleshy stalk. The interior bears two spiral arms (lophophores) bearing ciliated tentacles. The digestive tract is either with or without the arms. They are marine animals.

HALL II.—HIGHER INVERTEBRATES.

Phylum MOLLUSCA	This phylum includes the molluscs. They are bilaterally symmetrical animals with an unsegmented, soft, fleshy body covered by a mantle which usually secretes a calcareous shell of 1, 2 or 8 parts. Usually a head is present at the front end and a muscular ventral foot for locomotion. The digestive tract is complete. The respiration is usually by gills; they are marine, fresh-water or terrestrial.

um ECHINODERMATA	Echinoderms. They are radially symmetrical, exclusively marine animals. They usually exhibit a penta-radiate symmetry around a central axis. The body wall is composed of limy plates, usually forming a rigid or flexible endoskeleton with external spines. The digestive tract is either with or without the anus. There are small, tube-like external structures known as tube feet which serve for locomotion.
Phylum ARTHROPODA ..	Jointed-limbed animals. The body is typically composed of a head; thorax and abdomen, formed of segments which may be fused together to varying degrees or separated. Four or more pairs of jointed appendages are present. A chitinous external skeleton is present, covering all parts of the body. The digestive tract is complete and straight. They are either terrestrial or aquatic, and may be free-living or parasitic.

HALL I.—LOWER INVERTEBRATES.

SUBKINGDOM PROTOZOA.

Phylum PROTOZOA.

(One-celled Animals.)

The Protozoa are mostly one-celled, minute animals of microscopic size. They comprise the most lowly organized members of the animal kingdom. They are always found in a moist habitat, in sea water, in fresh or brackish water, or in moist soil or in decaying organic matter. Many are free living and free swimming, some are attached, while others are parasitic. Many Protozoans serve as food of other minute animals. This phylum includes many disease producing forms, such as those causing malaria, amoebic dysentery and the African sleeping sickness.

Some Protozoans are very simple in structure, while others are complex with specialized cell organs known as organelles which serve vital functions such as locomotion and excretion. The Protozoans constitute one of the largest groups of the animal kingdom, comprising over 30,000 different species and as individuals they far exceed all other animals in number.

Many of the free living forms build hard shells; examples of these are the Radiolaria and the Foraminfera, which inhabit the sea, and whose myriads of minute shells form extensive deposits on the ocean floor. The shells are microscopic and exhibit a great variety of form and structure.

The Protozoa are divided into five classes, namely, (1) Mastigophora, or Flagellates, with one or more whip-like flagella (e.g.. *Euglena*); (2) Sarcodina or Rhizopods, with processes for locomotion known as pseudopodia (e.g. *Amoeba*) (3) Ciliata or Ciliares, with fine, hair-like structures, serving for locomotion; (4) Sporozoa, with no locomotor organelles (e.g., *Plasmodium*, the malarial parasite); and (5) Suctoria, with cilia in the young and tentacles in the adult stages.

Because of their minute size, it has not been possible to display these animals in original suitably in this gallery. However, the structure and life histories of several species of the various groups of Protozo are graphically illustrated in this gallery by a series of diagrams accompanied by detailed explanatory labels. Besides, enlarged models of two of the most familiar and typical species of Protozoans, *Amoeba* and *Paramoecium*, with their various individual parts labelled, and models of the shells of two Foramniferan species are also exhibited.

Class Mastigophora or Flagellates.—The members of this group are characterized by the presence of one or more long, slender, filamentous structures known as the flagella at some or all stages in the life history. The flagella serve for locomotion. A typical example of this group is *Euglena viridis*. It is a solitary, free living, cigar-shaped organism containing chlorophyll. It reproduces by dividing into two longitudinally. This group is represented in this gallery only by enlarged diagrams, like many of the other groups of Protozoans. This Class also comprises a good number of parasitic forms including the blood flagellate *Trypanosoma* which causes sleeping sickness in man.

Class Sarcodina.—The common Amoeba (*Amoeba proteus*) is a member of the Class Sarcodina and appears to be the simplest of all living organisms. Its body consists of a clear, colourless, jelly-like mass of protoplasm of irregular shape and undergoes frequent changes of form. In spite of its extreme simplicity, it can move about, capture, digest and assimilate food, throw out indigestible matter, respire, excrete waste material, respond to stimulus, grow and reproduce itself. In short, it performs all the essential activities of animals. The amoeba moves by means of temporary, finger-like processes or extensions of its body, the pseudopodia. The food of the amoeba consists of minute plant organisms known as diatons. It feeds by enveloping the total food particle by means of its pesudopodia and reproduces by simple binary fission, i.e., by dividing into two parts when it reaches the maximum size. An enlarged wax model of the Amoeba with its principal parts labelled, is exhibited.

One of the important groups of the Class Sarcodina is the Order Foraminifera, including about 18,000 species. These are mostly marine and have an enveloping shell, with numerous openings through which long, thread-like processes of the protoplasm stream out and often branch freely and anastamose with one another. The shell generally consists of many chambers and presents a wide range of variation in form and structure. The shells of the different species also vary considerably in their size and shape. They are composed of gelatinous, chitinous or calcareous material. The Foraminifera have existed from very ancient Geological times and their accumulated shells have resulted in the formation of extensive rock strata. Enlarged models of the chalky tests (or shells) of two species of Foraminifera belonging to the genera *Polystomella* and *Frondicularia* are exhibited.

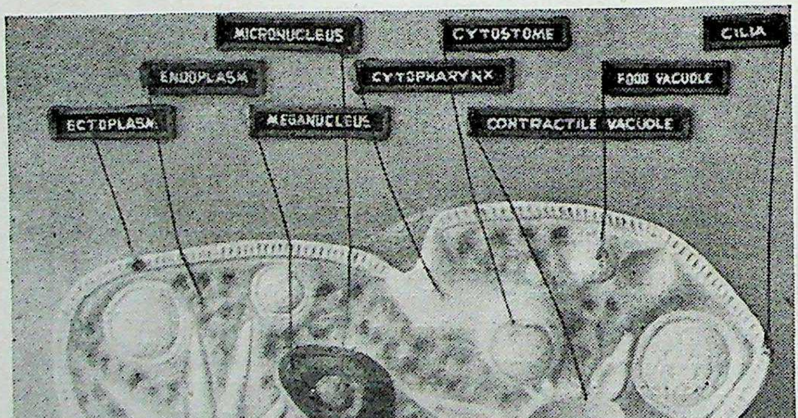

FIG. 1 – ENLARGED MODEL OF PARAMAECIUM CAUDATUM.

Class Ciliata.—The Ciliata are characterized by the possession of cilia (minute, short, hair-like structures) which serve for locomotion and assist in securing food. Each species has a constant and characteristic shape. They are the most specialized among the Protozoans and have different organelles for performing different vital functions. Many are free living, but some are symbiotic or parasitic in other animals. A few are found associated together in colonies. The reproduction in this Class is by simple asexual fission. In *Paramaecium* and some other Ciliates, there is at regular intervals a temporary union of individuals accompanied by a mutual exchange of nuclear material. This process is known as Conjugation and is believed to have a rejuvenatory effect. *Paramaecium* is a typical Ciliate commonly found in fresh water ponds. An enlarged plaster model of *Paramaecium caudatum* with all its parts and organelles individually labelled is exhibited (Fig. 1) besides an enlarged explanatory diagram included in the wall chart.

Class Sportozoa.—The Sporozoa are practically all parasitic. The structure of the Sporozoan body is simple and consists of a single cell rounded and elongate, with a single nucleus and without any locomotor organelles or contractile vacuoles. Food is absorbed directly from the host and respiration and excretion take place through simple diffusion. They multiply rapidly by simple asexual division (*schizogony*). They also produce sexual bodies which unite in pairs to form the fertilized cell (or *zygote*) which in turn develops into seed-lige bodies (*oocytes*) containing minute bodies known as *spores* and *sporozoites*, which in turn develop into the adults. This sexual process of reproduction is known as *sporogony* and there is an alternation of schizogony and sporogony in the life cycle of most sporozoans. Malaria in man is caused by the Sporozoan, *Plasmodium*, the malarial parasite which is transmitted by mosquitoes. The sexual phase of the life cycle is passed in the alimentary canal of mosquitoes. The life history of the Malarial parasite is illustrated diagrammatically in the descriptive wall charts exhibited in this gallery.

Class Suctoria.—This Class includes Protozoans which are attached to some substratum in the adult state. They have delicate protoplasmic filamentous structures known as "tentacles", but they are devoid of cilia in the adult state. The young, however, resemble the Ciliata in bearing cilia and are free swimming. The body of the adult Suctorian consists of a cell which may be spherical, elongate or branched variously in different species and is usually attached by a stalk or disc to some object. Some of the tentacles terminate in dilated knobs which serve as suckers and help in procuring food. Reproduction is effected by simple fission or budding. They inhabit fresh, brackish or salt water. This group is also illustrated only by diagrams in this gallery.

THE IMPORTANCE OF PROTOZOA TO MAN.

Although the Protozoa are of minute size, they are among the most important and interesting groups in the Animal Kingdom.

The enormous numbers of shell-bearing Protozoans, such as Foraminiferans and Radiolarians form immense masses of rock at the bottom of the sea. One of the illustrations exhibited in this Section shows them in position in such rock which, through changes in the earth's crust has come to form part of its highest mountain range.

The Protozoa are perhaps best known, however, as the cause of various diseases. Thus dysentery, though often caused by bacteria, may also be caused by amoebae. The malarial parasite belonging to the Class Sporozoa, the parasites causing Kala-azar, oriental sore and sleeping sickness belonging to the Class Mastigophora are classical examples of disease-producing Protozoans. Other Protozoan parasites cause other diseases, some of them severe, in domestic and other animals.

Those which attack the digestive organs usually produce " spores " in which the delicate living substance is protected by a hard outer case and it is in this form that the parasite passes from one host to the next. Thus spores of the amoeba which causes dysentery pass out of the body of the host in the excrement. Files breed in the excrement, and if spores of the amoeba are among them, they will hatch out in the digestive system of the person who eats the foodstuff contaminated by the flies. and begin to multiply.

Parasites which live in the blood usually make use of biting insects in passing from one person to another, and are indeed so dependent upon this means of transmission that different parts of their life cycle usually require to be passed in the two different hosts, so that the whole cycle as shown in the illustrations exhibited, cannot be completed in either alone. Thus the malarial parasite, when introduced into the blood of a man by a mosquito multiplies rapidly and ultimately produces male and female cells. These cells must of course unite before further multiplication can take place, but this they only do if a suitable type of mosquito (*Anopheles*) bites their host and draws them with his blood into its stomach. Such diseases, therefore, cannot be spread directly from man to man, but must die out in the absence of the intermediate host; and the most effective way of preventing them is by the extermination of this host.

SUBKINGDOM METAZOA.

Phylum MESOZOA.

(Multicellular or tissue animals.)

The Mesozoa are minute. worm-like parasitic animals with solid bodies composed of a small number of cells. This is a small group, the exact systematic position of which is doubtful. As, however, they resemble one of the larval stages of the Trematodes more closely than anything else, they are usually associated with the Platyhelminthes (flatworms). The Mesozoa resemble some colonial Protozoans. They are intermediate between unicellular and multicellular animals and are regarded by some as degenerate forms, possibly related to the Platyhelminthes. *Dicyema* is a typical example, parasitic in the nephridia (excretory tubules) of the octopuses and squids. As the actual animals are very minute and obscure, only an explanatory diagram is exhibited in this gallery to represent this group.

Phylum PORIFERA.

(*Sponges.*)

Sponges are lowly organized, multicellular animals. They were once thought to be plants, and their proper place in the animal kingdom was not determined until about 1857. They are perhaps the lowest group of animals among the Metazoa and are sedentary, being attached to rocks, shells or other solid substrata. Some sponges show radial symmetry, but the majority are irregular masses. The various species differ widely in their shape and appearance. Some are thin, flat, crust-like forms while others are vase-like, branched, globular or more varied in form. They range in size from 1 millimetre to 2 metres in diameter. Many species are greyish or brownish or of a dull colour, but others are brilliantly red, orange, yellow, blue, violet or black. Most sponges are marine, being found at all depths from the low tide level up to depths of about three and half miles. A few species are freshwater.

Though a sponge is a multicellular animals, it is the simplest type of cell assemblage known outside the unicellular group, Protozoa. The organs are, for the most part, single cells, less specialized than the cells of higher groups of animals, and therefore able to perform a variety of functions.

The term "sponge" is popularly associated solely with the soft elastic bath sponge; but this is only the skeleton by which the living tissues of this particular kind of sponge are supported. In many sponges this skeleton consists largely of minute spicules; in some these are so closely packed as to give it a stony hardness; while in others they are individually so large as to give it the appearance of spun glass (e.g., the spicules in the Glass Rope Sponge, *Hyalonema*, a specimen of which is exhibited). The tough texture of the sponges is due to the presence of these skeletal elements. The spicules may be of calcareous or silicious nature and are very varied in shape in different sponges and under the microscope they appear as marvels of beauty and symmetry. The spicules may occur alone or combined with a network of horny fibres composed of a substance known as *spongin*. These spicules are of great classificatory value as the classification of sponges is based to a large extent on the kinds and arrangement of these skeletal materials.

The simplest form of sponge is a minute sac, attached to the bottom and open at the top. This sac is lined with cells, each provided with a collar and a whip-like structure, the *flagellum*. Most sponges, however, are more complex and consist of more or less extensive groups of such sacs or chambers similarly lined, and have a more or less elaborate system of canals within their bodies. The surface of the sponge body bears numerous pores; hence the name *Porifera* for the phylum. In addition to the numerous small pores there are one or more larger openings known as *oscula*. The minute pores serve as the inhalent pores through which water enters the sponge and the oscula as the exhalent pores through which the water is driven away. This constant current of water is vital to the sponge as it serves for its nutrition, respiration and excretion. This current of water is produced by the lashing movements of the protoplasmic threads or flagella possessed by the cells lining the chambers within the body.

Sponges multiply both asexually and sexually. Parts of a sponge lost by injury or accident can be regenerated. It is also interesting to observe that if a sponge is squeezed through fine-meshed silk so that the cells are separated they will come together by amoeboid movements, unite and regenerate into a sponge like the original species. Many kinds of sponges multiply by budding, the buds either separating from the parent sponge, or remaining attached.

The commercial " bath sponge " is the flexible skeletal remains of a well-known species of marine sponge with all its living protoplasm removed. In the common bath sponge, the spongin alone is present forming the tough supporting skeleton which is sold as the commercial sponge. These sponges inhabit deep waters and are obtained by divers or speared from boats by means of long-handled forks. The living sponges are covered and permeated by slimy living tissues and it is only after these have decayed and the horny skeleton has been washed free from them that the sponge is ready for use. The bath sponge forms the basis for a flourishing industry in the warm shallow waters of the Mediterranean sea and the Gulf of Mexico, around Florida and the West Indies.

Freshwater sponges.—Freshwater sponges are included in the family Spongillidae which comprises about fifteen genera and 150 species, confined to the fresh waters. They grow attached to sticks, stones or plants, as tufts or irregular masses. Some are yellowish or brown, but others are green owing to the presence of symbiotic algae. *Spongilla* is a familiar example of a freshwater sponge. All freshwater sponges (and some others, too) form internal buds or gemmules which help them to tide over adverse conditions. As the sponge dies and disintegrates, the minute gemmules drop out and survive, growing into a new sponge when conditions become favourable.

Classification of sponges.—Sponges are classified into the following three classes according to the nature of their skeleton :—

Class 1—Calcarea	Calcareous sponges in which the spicules are calcareous ; the surface of the body is bristly and dull coloured. They are small, simple sponges, mostly less than six inches in size.
Class 2—Hexactinellida .	This includes the so-called Glass Rope Sponges in which the spicules are silicious and 6—rayed, either separated or united in net works ; some skeletons resemble spun glass. Endless modifications of such spicules occur, as one or more rays may be reduced or absent, or enormously enlarged, branched or curved. These sponges are found mostly at great depths, e.g., *Hyalonema*, the Glass Rope Sponge ; *Euplectella*, Venus' Flower Basket.
Class 3—Demospongiae ..	This includes sponges with skeletons of silicious spicules or spongin, or of both, or none. This class includes the bath sponge and almost all the sponges found in shallow water. A few (Family Spongillidae) have established themselves in freshwater and acquired the power of forming hard bud-like bodies (*gemmules*) containing living cells, by means of which this species is able to survive periods of drought. This class is divided into the following three Orders.
Order 1—Tetractinellida ..	Spicules, when present, are typically with four axes (tetraxons) ; spongin is absent. The body is mostly

		rounded or flattened, with no branches or projections. They are mostly inhabitants of shallow waters.
Order 2—Monaxonida	..	Spicules with only one axis (monaxon). Spongin is present in some species. The shape of the body is varied. They inhabit mostly coastal waters up to a depth of 150 feet, but some are found even at a depth of 3½ miles. This Order includes the most common species of sponges, e.g., *Suberitis*, *Cliona*, the boring sponge and *Spongilla*, the fresh water sponge.
Order 3—Keratosa	..	This includes the horny sponges with a skeleton of a network of horny fibres (spongin). Spicules are absent. The shape is usually rounded and the surface leathery. They are dark coloured sponges. This group includes the Bath sponge of commerce, *Spongia*.

The exhibits relating to Sponges in this gallery consist of a diagram illustrating the structure of sponges and a series of specimens, both wet and dry-preserved, belonging to species common around the coasts of South India, especially in shallow waters. *Hyalonema* is the Glass Rope Sponge, which is found at the bottom of the sea rooted in the loose mud by means of a tuft of long, glassy spicules.

Many species, such as *Suberites inconstants* (Fig. 3) *Clathria indica*, etc., and species of *Raspalia*, *Axinella*, etc., are common around the Gulf of Manaar, Krusadai Island, Pamban, and off the coast of Tuticorin. Individual specimens of these species are extremely variable in shape and external appearance and it is therefore difficult to identify them merely on the basis of their shape. Off Krusadai Island, there is a particular Bay—the Sponge Bay—which is specially rich in specimens of marine sponges. The largest specimen in the exhibited series is *Petrosia testudinaria* (Fig. 2) from Tuticorin. It is a large, trough-shaped sponge with a bowl-like depression in the centre, and is a deep-sea sponge. *Spongilla carteri* is a freshwater sponge, and the exhibited specimen of this species is from the freshwater tank in the Museum compound.

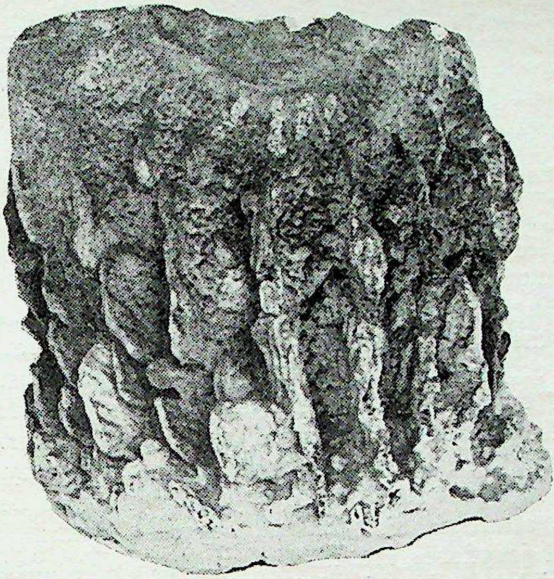

FIG. 2—PETROSIA TESTUDINARIA: A LARGE DEEP SEA SPONGE FROM OFF TUTICORIN.

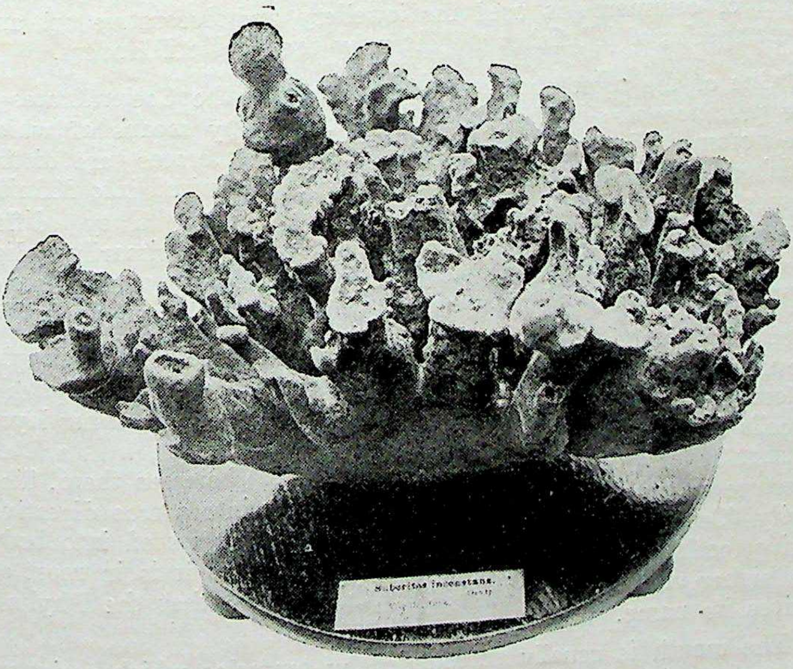
Suberites inconstans.

FIG. 3—SUBERITES INCONSTANS: A MARINE SPONGE.

Phylum COELENTERATA.

(*Hydroids, Jelly-Fishes, Sea Anemones and Corals.*)

This phylum is the lowest group among the Metazoa in which the cells are organized into definite tissues. It includes the hydroids (plant-like animals), jellyfishes, sea anemones and corals and a host of other diverse forms of the same fundamental structure. The individuals occur either as solitary forms or in colonies and are of two types: (1) the *polyp* with a tubular body, having one end closed and attached and the other with a central mouth usually surrounded by tentacles and (2) the *medusa* which is a free swimming form with a gelatinous, bell shaped body bearing tentacles at the margin and having the mouth on a central projection of the concave surface. Both forms are variously modified and both of them occur as different phases in the life cycle of many species, one form alternating with the other. All are aquatic and almost all of them are marine, only a very few forms being found in freshwater. Many hydroids grow as dense, plant-like colonies attached to rocks and other substrata, while the *medusa* and jellyfishes are free-swimming. Sea anemones are beautiful, brightly coloured, flower-like animals often abounding on rocky sea coasts, attached to rocks, and corals with calcareous skeletons, often form extensive reefs on tropical shores. Many of the Coelenterates are luminescent.

Coelenterates are of little economic importance. The Precious Coral of commerce is used for jewellery and decorative art and some species of jellyfishes are eaten by the Pacific Islanders.

One of the most characteristic features of the Coelenterates is the presence of stinging cells (nematocysts) by means of which they often inflict severe stings. The Coelenterates are distinguished from sponges, in having their cells organized into definite tissues and in having a distinct digestive cavity. They differ from the next phylum, the Ctenophora, in being primarily radial in symmetry, in possessing stinging cells, in having a polyp stage in the life history, and in reproducing both sexually and asexually.

The body of a Coelenterate, like that of a sponge, is a simple sac in its fundamental form, but its tissues are much more highly differentiated. The body wall consists of an outer and inner layer of cells (termed ectoderm and endoderm respectively), with a layer of more or less gelatinous substance (mesoglea) between them. The aperture of the sac is a true mouth, leading into a true digestive cavity (Coelenteron). But this cavity is not separated into body cavity (coelom) and digestive cavity (enteron) as it is in most of the higher animals, and it is from this feature that the Phylum derives its name.

The mouth is usually surrounded by tentacles which assist in the capture of food and the body wall contains minute stinging cells or " thread cells " (nematocysts) usually in immense numbers. In

The digestive cavity is branched into four gastric pouchers containing slender tentacle-like gastric filaments with thread cells or nematocysts. The sexual cells are developed in U-shaped gonads placed one in each gastric pouch. There are also different types of sense organs.

Jellyfishes may occur either singly or in large numbers in the form of schools. They swim feebly by rhythmic contractions and large numbers are sometimes washed up on the shore. Their food consists of small marine invertebrate animals which are captured and paralyzed by the stinging cells on the oral arms and then carried into the mouth.

The fertilized egg swims for some time and then settles down, attaching itself to the sea bottom, and develops into a minute polyp with a wide mouth. It feeds and grows and then undergoes transverse fission (*strapilisation*). The minute saucer-shaped buds with an eight-lobed margin (*ephyrae*) become free and swim about, growing into the adult jellyfish in course of time. Thus there is an alternation of generations in the Scyphozoa also, but in this Class the polyp stage is suppressed and the free swimming medusoid generation is the dominant phase.

Several species of jellyfish occur around Madras and Pamban Coasts. Some of them can cause very painful stings and many specimens may be seen washed up on the beach. Specimens of two species belonging to the genera *Rhizostoma* and *Tamoya* and diagrams illustrating the structure of the Scyphozoa and the life history of a typical Scyphozoan, *Aurelia*, are exhibited.

Class ANTHOZOA.

(*Sea Anemones Corals, etc.*)

The Anthozoa include a very large variety of widely differing species of Coelenterates commonly known as the sea anemones, sea pens, sea fans and a host of other solitary and colonial skeleton-bearing forms known as the corals. The Anthozoa are exceptional in that they lack a medusoid stage altogether in their life history.

The Anthozoa are exclusively marine. The body of a typical individual consists of a flower-like polyp varying greatly in size, and exhibiting a marked biradial symmetry in the arrangement of the gullet and the internal partitions of the body cavity. The Anthozoa abound in warm, shallow waters of the tropical and temperate seas, but some inhabit the polar zone.

The body of the sea anemone is typically cylindrical, vase-shaped with the mouth situated at the upper free end which is developed in the form of a flat oral disc which bears numerous short

In colonial forms, whether fixed or free swimming, different individuals or "polyps" are often modified for the special performance of one of three different functions, namely, (1) the stinging and capture of the prey, (2) the eating and digestion of the prey and (3) the propagation and disposal of the species. In the most typical forms (e.g., *Obelia*) there is an alternation of generations between the jellyfish and the fixed, plant-like form, the former arising as buds from the latter and the latter from eggs produced by the former, but in many species one or other of these generations may be more or less completely suppressed.

This Class is subdivided into a number of Orders, in one of which (the Hydrocorallina) the polyps are minute and protrude through pores in a massive calcareous skeleton. In the Order *Trachylina* the Hydroid generation is more or less completely suppressed and the normal form of the animal is medusoid, and in the Order Siphonophora, the animals occur as free-swimming colonies with several different kinds of polyps a mong which there is a division of labour. The upper end of the colony is a supporting float. The stinging cells are large and powerfully developed in this Order. The Portugese Man-of-war, *Physalia*, of which a spirit-preserved specimen is exhibited, belongs to this Order.

Specimens of many species of Hydroids common in the Gulf of Manaar and around Madras Coast, *Sertularia, Lytocarpus, Plumularia, etc.*, and others including Siphonophores such as *Physalia, Velella,* and *Porpita* are exhibited as wet preserved specimens in jars. Besides, illustrative diagrams explaining the structure of a typical Coelenterate polyp and the life history of *Obelia*, etc., showing the alternation of the hydroid with the medusoid generations, are also exhibited in the Gallery.

Class SCYPHOZOA.

(*Jellyfishes.*)

The Class Scyphozoa or Scyphomedusae includes the Medusae or Jellyfishes. The Medusoid stage is predominant in this group. The medusa ranges in size from an inch to seven feet in diameter and consists largely of the jelly-like substance, the *mesoglea*; the polyp stage is suppressed or lacking. When present, the polyp gives rise to medusae by transverse fission instead of by budding.

The body of the jellyfish is in the shape of an inverted umbrella, shallowly convex above and concave below and is fringed by a row of marginal tentacles. The velum (inwardly directed membrane at the margin characteristic of the medusoid stages of Hydrozoa) is absent in this Class. The mouth is situated in the centre of the concave oral surface on a short stalk-like structure, the manubrium, which is drawn out into four tapering oral arms.

The digestive cavity is branched into four gastric pouchers containing slender tentacle-like gastric filaments with thread cells or nematocysts. The sexual cells are developed in U-shaped gonads placed one in each gastric pouch. There are also different types of sense organs.

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The body of the sea anemone is typically cylindrical, vase-shaped with the mouth situated at the upper free end which is developed in the form of a flat oral disc which bears numerous short hollow tentacles surrounding the slit-like mouth. The base, known as the pedal disc, serves for attachment to rocks and other solid substrata. The mouth opens into the internal cavity through a tube known as the "*stomodaeum*" which is suspended by means of partitions known as "*mesenteries*" stretching to it from the body wall and usually continued into the lower parts of the digestive cavity as well. Each mesetry bears at its free inner margin a thickened convoluted filament—the septal filament which is continued below as a thread-like extension. These filaments can be protruded through pores in the body wall or through the mouth and assist in capturing the prey. The sexual cells develop along the margins of the septa and are discharged through the mouth. Fertilization takes place in the open sea and the fertilized egg develops into a free-swimming larva which in course of time attaches itself to some substratum by the aboral end and grows into an adult anemone.

Sea anemones live attached to rocks, stones or some other firm surface but they can also creep slowly on their pedal discs. When undisturbed and submerged in water in their natural habitat, the tentacles are beautifully extended, but if irritated or if exposed by a receding tide the tentacles and the body contract to a varying extent. The food of the sea anemones consist of small molluscs, crustaceans and other marine invertebrates and sometimes also small fish which are paralyzed by the stinging cells and carried inwards to the mouth by the tentacles.

The Anthozoa are divided into two main subclasses, namely.

Subclass I—Alcyonaria and
Subclass II—Zoantharia.

In the Alcyonaria, the tentacles are always eight in number and are pinnately branched (i.e., like a feather), while in the Zoantharia the tentacles are either few (sometimes only six) or numerous, but never eight, and they are usually simple, but sometimes branched.

Subclass ALCYONARIA.

The tentacles and mesenteries are eight in number, the former being pinnately branched (i.e., branched like a feather). The skeleton is calcareous or horny, the former being almost always in the form spicules. This sub-class includes many familiar species such as the following: (1) soft corals (Order Alcyonacea) in which the polyps have their lower parts fused in a fleshy mass and having only their oral ends protruding free and in which the skeleton consists of separate limy spicules (e.g. *Alcyonium digitatum*, popularly known as the Dead man's fingers); (2) the organ pipe corals (*Tubipora musica*) (Fig. 4) in which the polyps arise separately from a common stalk or stolon and the skeleton consists of fused tubes (Order Stolonifera); (3) the Sea Fans or Fan corals (Order Gorgonacea) which are horny corals with the colonies

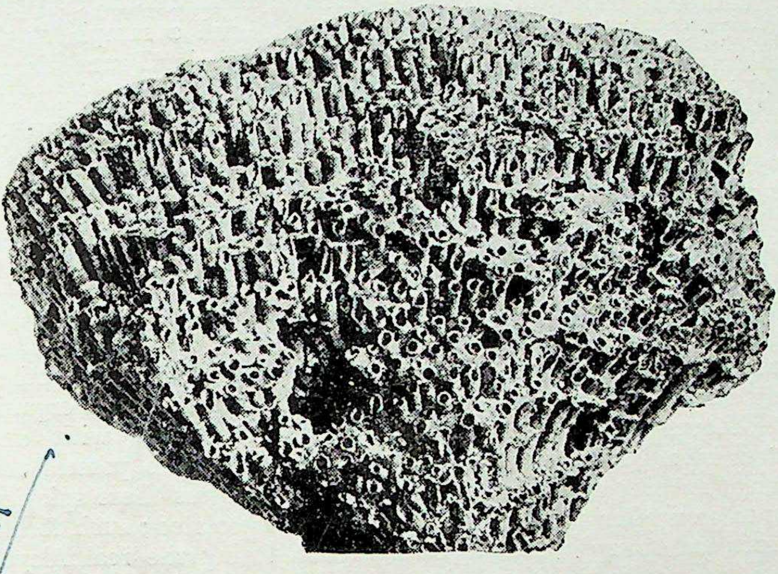

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FIG. 4—TUBIPORA MUSICA: THE ORGAN PIPE CORAL.

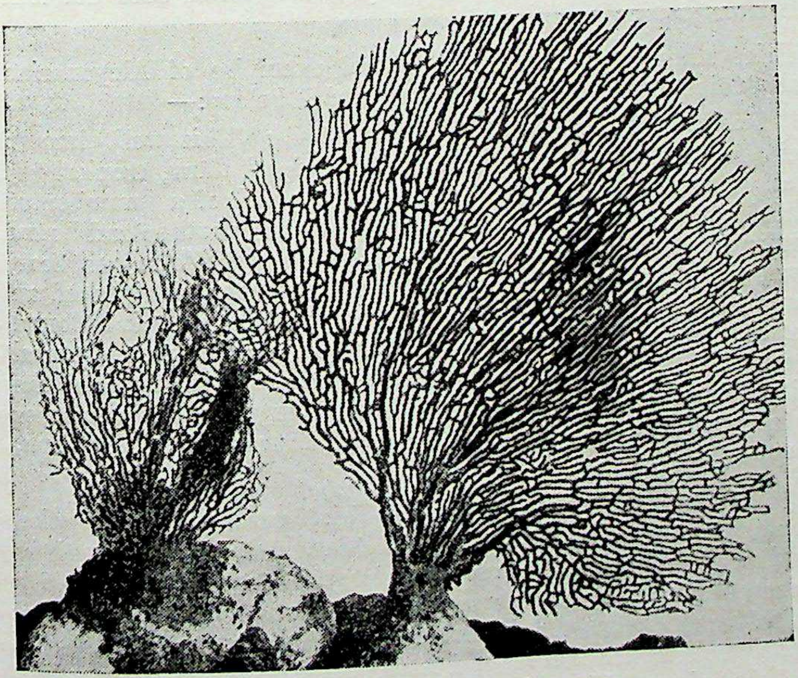

FIG. 5—LEPTOGORGIA MINACEA: GORGONIAN OR SEA FAN.

usually in the form of branching, plant-like structures with the skeleton consisting of an axial core of calcareous spicules or of horn-like material (gorgonin) or both. The precious coral of commerce (*Corallium nobile*) also belongs to this Order. Several specimens of both wet and dry-preserved Fan Corals *Gorgonia* (Fig. 5) of bright colours (yellow and red) and a sample of the precious coral are exhibited; (4) the Sea Pens (Order Pennatulacea) in which the colony is fleshy consisting of one long axial polyp and many small polyps along the sides of the branches, above the bare stalk. The skeleton consists of limy spicules (e.g., *Pennatula*, the Sea Pen, which is feather-like in appearance).

ALCYONARIAN CORALS.

The Alcyonaria form a very well defined group of marine organisms, but they exhibit great variety in the form and texture of the skeletal structures they produce. As with many other corals, the Alcyonaria are colonial; a large number of unit organisms, known as polyps are in organic connection with one another by a system of nutritive canals. They also possess the power of forming calcareous spicules. In some forms these spicules cease to grow after a certain stage and remain isolated; such forms are soft and spongy. But in others, constituting the real Alcyonarian corals (like the organ pipe coral and the precious coral), the spicules grow and become jammed together forming a large permanent skeleton. The colour of the Alcyonarian corals does not fade even after the death of the polyps.

Brief notes on some of the typical examples of Alcyonarian corals exhibited in this gallery are appended below :—

Tubipora (Organ Pipe Coral) (Fig. 4) : This well known species of coral is very widely distributed in shallow, tropical sea water. The skeleton of this form is composed of a number of cylindrical tubes arranged almost parallel to one another and bound together by a series of transverse plates or platforms so that, viewed in section, they resemble the arrangement of pipes of an organ; hence the popular name, " Organ Pipe Coral ". It is found alive, attached to shells, corals or stones on reefs of most tropical shores. When seen alive under water, the familiar form of the coral is hidden by a mantle of emerald green tentacles. The colonies vary a great deal in their shades of red colour and in the shape, size and spacing of the tubes.

Corallium (Precious coral).—This genus includes the Precious coral of commerce, which is the first coral mentioned in literature; it had been famous throughout the ages for its beauty and the occult powers it was supposed to possess. The specimen exhibited here shows the hard, red coral substance that is commonly sold in the market and is the axial or central supporting core of the colony. The substance of the precious coral is of a dark red colour and is composed of a large number of spicules closely and densely fused together. The Precious coral (*Corallium nobile*) comes chiefly from the Mediterranean and Japanese seas and has given rise to a flourishing industry in these countries. Precious coral is used principally in the manufacture of beads and cameos.

Gorgonia (Sea Fans) (Fig 5).—This is a group of Alcyonaria in which the substance Keratin (or Gorgonin) closely allied to horn, enters into the composition of the skeletal structures. In *Gorgoma* the axis is formed of pure Keratin. In a few Gorgonians, there is simply a long, unbranched stem attached by a basal expansion to some substratum but usually the main stem soon divides into secondary branches and these ramify again before they terminate in numerous delicate twigs, but the branching throughout takes place in one plane only. This results in a fan-shaped structure from which these forms derive their popular name " Sea Fans ". Several specimens of different colours notably yellow, red and brown, are exhibited in this gallery. They generally attain a very much larger size than the specimens exhibited

Pennatulids (Sea Pens).—These are normally feather-like in appearance and resemble the quill feathers from which pens were made in the olden days; hence the popular name Sea Pens. They bear a quill-like horny skeletal rod by which the main axis of the colony is supported. The colony is fleshy, consisting of one big axial polyp and with numerous small polyps along the sides, above the bare stalk. The skeleton consists of calcareous spicules embedded in the fleshy body of the colony. One common kind of Pennatulid found on the Madras Coast—a species of *Cavernularia*, however, is not feather-like and has no central horny axis. In the living condition, this may be found beautifully expanded, with the numerous semi-transparent polyps scattered all over the surface of the animal.

Subclass ZOANTHARIA.

The tentacles and mesenteries are few to many in number (usually six or twelve or more), but never eight. The tentacles are sometimes branched, but are usually simple and never pinnately branched. The skeleton, when present, is solid and is mostly calcareous, sometimes horny. Spicules are absent. This subclass includes the sea anemones and the majority of corals, including the massive reef building stony corals and the block, horny tree corals.

In the sea anemones (Order Actinaria) there is no skeleton and the polyp is of small size, columnar, with a muscular wall and usually a disc-like expansion at the base for attachment. They are essentially solitary animals, but some are closely grouped so as to resemble colonies. They are generally attached to rocks or other animals, such as molluscan, shells, etc., or embedded partly in sand

and are sessile, but not permanently fixed. Some sea anemones are attached to shells inhabited by hermit crabs and afford a good example of commensalism.

One of the common species of sea anemones found in the sand on the banks of backwaters around Ennore and Adyar is *Sphenopus marsupialis*. It is a somewhat flattened, dark greyish animal about an inch or two in length, usually broad and more or less triangular at one end, and narrower but more plump and more or less cylindrical at the other end. Its almost black colour and tough, leathery texture are due to a protective layer of fine sand grains embedded in the skin. The broad, flattened end serves to anchor the body firmly in sand or mud in which the anemone normally lives embedded with the grey disc-like oral end alone projecting. Specimens of this species and a few other typical solitary sea anemones common on South Indian shores are exhibited. Some of these sea anemones are particularly common in the mud flats and lagoons in and around Krusadai Island and the neighbouring areas in the Gulf of Manaar. They include the following more or less familiar types :—

Anemonia sp.—This is a small, pale reddish anemone with a brownish violet base. The basal disc is well developed and broad. The tentacles are numerous and situated in the outer portion of the disc. These are active anemones and readily change their position of attachment.

Bunodactis sp.—This is a common form occurring on the reefs on the sandy shores at Krusadai and several distinct species may be recognized. Some of them burraw in sand and are common on the mud flats at Kundugal Point near Krusadai Island. In some of them the disc is green or greenish yellow and the tentacles are brown or brownish yellow or greyish violet. In some species, large numbers often occur together, covering the surface of dead coral masses.

Gyrostoma sp.—This is a fine, large, vase-shaped, burrowing sea anemone found in the sands at Kundugal Point in Pamban and at Thonithurai. It is one of the most beautiful anemones occurring at Krusadai. The body is very long, narrow towards the base, broadening towards the oral disc and reaching the maximum width at the margin. The body is buried in the sand, in the living condition, with the disc and tentacles exposed and resting on the sand.

Stoichactis giganteum.—This is a very large sea anemone commonly found half buried in the sand in many places in and around Krusadai Island. The body is buried in the sand while the large, lobed disc is exposed and lies flat on the ground. The base is well developed. The disc bears innumerable very short, almost knob-like tentacles which are very sticky. The disc may sometimes reach more than a foot in diameter. The animals are generally greenish or greenish grey, but white or grey colour varieties are also found.

MADREPORARIAN CORALS.

(*Stony corals*).

Some sea anemones secrete a limy **skeleton** and thus produce stony corals—the corals which largely contribute to the formation of reefs. Stony corals may be either solitary or colonial. The solitary corals (e.g., *Trochocyathus*, *Flabellum*, *etc.*), are more or less shaped like a small cup, within which delicate plates or septa radiate from the centre. Most of them are found attached to rocks or other solid objects.

The majority of species of stony corals, however, are colonial, and in such coral colonies, the polyps multiply by budding or by division repeatedly and thus produce in course of time, enormous stony masses that may attain a very great size and weight. In many places, especially in the tropical waters, these colonies become so large and numerous that extensive coral reefs are formed, and deposits of coral rock are laid down.

Several species of coral abound in the Gulf of Manaar and neighbouring coasts in South India and selected specimens of a number of these species are exhibited in this gallery. The exhibits also include a large group in which corals belonging to a number of different species but inhabiting more or less similar situations are assembled together and displayed as they normally occur in a living coral reef.

The more important types of corals exhibited are briefly described below :—

SOLITARY CORALS.

Fungia.—This is a solitary coral, commonly known as the Mushroom Coral (Fig. 6) as it bears a curious resemblance to the inverted disc of a mushroom. It differs from the other corals of the reef in being free in the adult state. The upper surface of the coral bears a large number of close-set, vertical, radiating laminae—the septa, which are united by transverse bars known as synapticulae. The large, single polyp that secretes this coral has a slit-shaped mouth in the centre of the disc above the central depression. The young of *Fungia* is stalked and attached.

Herpetolitha.—This is another type of solitary coral closely allied to the circular mushroom coral, *Fungia*, but is readily distinguished from the latter by its elongated form, which is sometimes bent in a serpentine fashion. Running along the middle of the upper surface is the long, deep, fossular groove, with the septa arranged on either side of it.

Other solitary corals occurring in the Pamban area are included in the family Turbinollidae. The corals included in this family are mostly solitary in habit and are either attached to rocks, shells or other foreign objects, or in some cases rest freely on a sandy bottom. They differ from the solitary mushroom corals of the family Fungiidae in having usually smooth septa which are not joined together by bars (*synapticulae*). *Trochocyathus* is a common genus of this family represented in the Gulf of Manaar, where the cup-like specimens are often found firmly attached to rocks in shallow water.

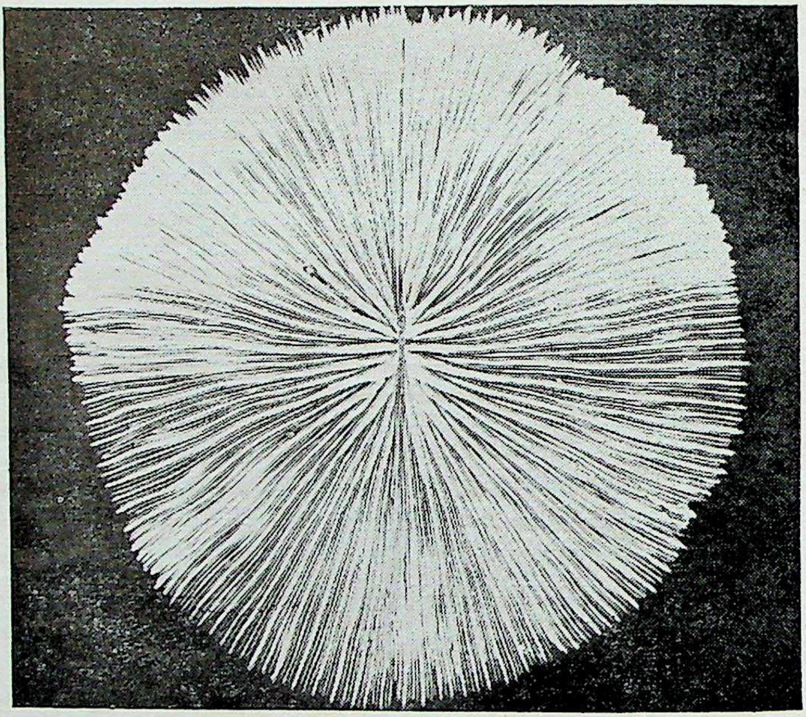

FIG. 6—FUNGIA ECHINATA: THE MUSHROOM CORAL.

Flabellum.—This is a very widely distributed genus of solitary corals, also grouped under the family Turbinollidae. Most of the forms included in it are oval in cross-section. The outer wall does not show any trace of ribs, but there is a series of more or less well marked transverse lines of growth. In this genus, the polyp is confined entirely to the inside of the calyx and does not overflow as in many of the corals, so that the outer wall of the calyx is always wholly exposed.

COLONIAL CORALS.

Family *Oculinidae.*—Corals of this family form large imperforate branching colonies bearing numerous calices separated from each other by considerably wide intervals. The genus *Oculina* to which the specimen exhibited here belongs, occurs at a depth of a few fathoms in the warmer tropical seas. The substance of the coral in these forms is very hard and solid and the surface is also very smooth.

Family *Astraeidae*.—This family includes a wide variety of stony corals known as the Star Corals which contributed largely to the building up of the coral reefs of the past Geological ages. The specimens exhibited in this gallery belong mostly to the following important genera :—

Galaxea.—This genus is widespread on the East Indian tropical reefs; at Krusadai in the Pamban area they are so plentiful on one of the local reefs that the reef itself is commonly known as the " Galaxea Reef ". The colony is frequently dome-shaped or hemispherical, sometimes throwing out thick lobes or branches, but never being completely dendritic (i.e., tree-like in branching). When the *Galaxea* colony is alive, the soft flesh covers the whole surface of the colony. as with a mantle and assumes various brilliant colours in different localities.

Favia.—This genus includes corals which are usually hemispherical or almost spherical in shape, without lobes or branches, but sometimes encrusting in habit. The surface of the coral consists of a large number of close-set cups or calyces, about 10 mm. in diameter which project slightly above the general level of the colony. The calyces are usually circular in outline, but they may become distorted by overcrowding.

Goniastraea.—In this form. which is another widely distributed coral found on the tropical reefs. the calyces are so densely crowded together that the thecal walls are actually in contact, the *coenosteum* or general surface of the colony being apparently absent. As a result of the crowding the calyces have lost their rounded contour and become more or less angular.

In *Favia* and *Goniastraea*, some of the calyces become elongated and then constrict to form two calyces. In more complex types, the elongation takes place, but the construction is delayed so that the calyces assume the form of long, straight or sinuous grooves, provided on each side with a row of septa and separated by ridges from similar adjacent grooves. This modification leads, through many intermediate types. to the extreme from known as the " brain corals " in which the sinuous grooves resemble the convolutions on the human brain.

Maendrina (*Coelaria*).—This genus includes the brain corals (Fig. 7). In this group of corals. the calyces are principally represented by long, sinuous valleys. Between the valleys there are ridges representing the fused walls of the calyces. There are numerous close-set septa and a median spongy columella. The sinuous calyces give the rounded surface of the coral an appearance similar to the convoluted surface of the human brain : hence the name " brain corals ". In a living brain coral, the valleys are covered by a continuous lamina of soft, fleshy substance. The colour of the living expanded polyps of the brain corals is often very vivid and brilliant.

Merulina.—This coral, occurring in the Indo-Pacific waters, is one of the commonest of the foliaceous type of corals included in the family Astraeidae. In general form, it resembles a huge, cabbabe-like structure attached by a thick stem and giving off, more or less horizontally a few large fronds or "leaves". The upper surface of the fronds presents a roughly undulating appearance and bears a series of alternating ridges and depressions. As in the brain corals, there is a complete continuity of the calyx units.

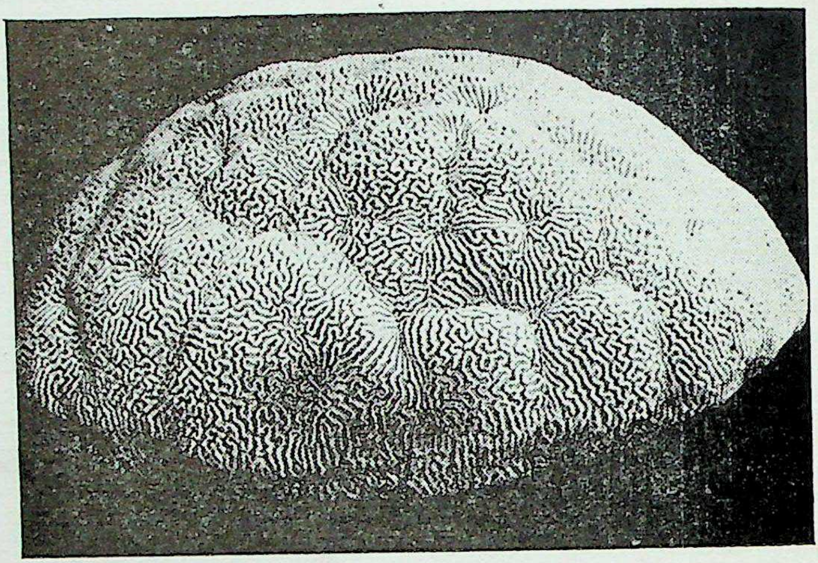

FIG. 7—COELARIA ARABICA : THE BRAIN CORAL.

Echinopora.—This is another typical foliaceous coral, resembling somewhat a huge, cabbage-like vegetable. It is attached by a thick stem and sends out more or less horizontally, a few large, thin fronds or laminae. On the upper surface of these fronds, the calyces are arranged at considerable intervals. These corals are also richly provided with small, sharp spines. The large, frond-like expansions are brittle and somewhat fragile, and break easily even under moderate pressure.

Family *Madreporidae.*—The corals belonging to this family comprise the majority of the living reef-building corals and probably contribute a larger proportion of the calcareous substance of which the reefs are composed than any other group of corals.

Madrepora.—The genus Madrepora is probably the most widely distributed and abundant of all reef-building corals of the world. These corals attain a large size and form very extensive colonies. Several specimens of *Madrepora cervicornis*, the Stag Horn Coral (Fig. 8), are exhibited in this gallery. This species represents one of the most characteristic forms assumed by these corals. There is usually a long, thick, erect, main stem from which large, irregular, lateral branches are given off, which subdivide, but rarely anastamose. This form is popularly known as the Stag Horn Coral

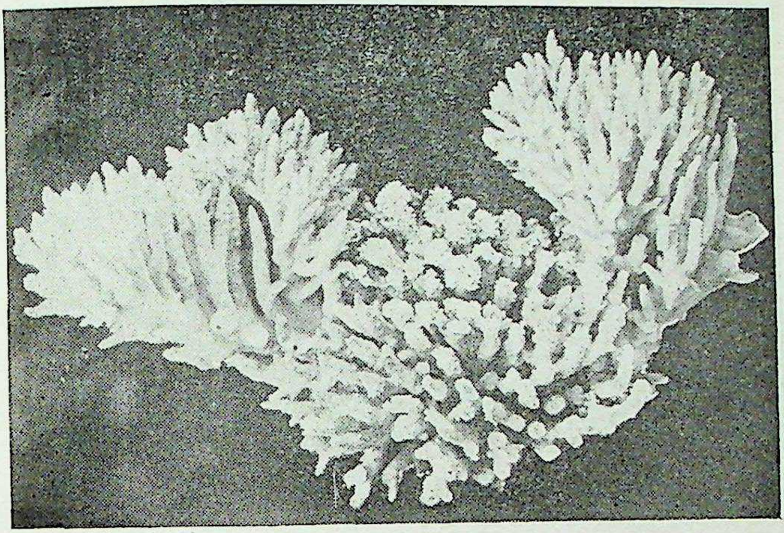

FIG. 8—MADREPORA CERVICORNIS: THE STAG-HORN CORAL.

from its resemblance to the branching horn of the stag. A characteristic feature of the genus *Madrepora* is that each terminal branch bears at its extremity, a single, large, apical calyx, and below this a number of oblique calyces of smaller size arranged like a series of brackets on all sides of the branch.

Porites.—This genus is another very important reef-building coral, widely distributed in the tropical seas. In some seas, blocks of *Porites* attain an enormous size (even as much as 30 to 40 feet in diameter), and appear to be the principal factors in the construction of reefs, but in others, they are relatively small, and are found only as isolated masses. The forms assumed by the colonies are very varied, but they are generally massive, spherical, lobate or encrusting. The surface of the corallium is seen to consist of a very large number of small calyces with common pentagonal walls. The colour of the living *Porites* is often very brilliant.

Montipora.—This is another important reef building coral, widely distributed in the tropical seas of the Old World, but absent in the Atlantic Ocean and the West Indian waters. The specimens vary a great deal in appearance and often attain a very great size. They may be rounded and massive or encrusting, branching or foliate. A very fine, large, massive specimen of *Montipora* in the form of a miniature hillock (Fig. 9), is exhibited in this gallery in a separate show case. All parts of the colony are profusely perforated.

Turbinaria.—This genus differs from the typical Madreporarian corals in several respects. The adult colony is in the shape of a large, shallow bowl attached by a thick stem to the rock. The upper surface of the bowl-shaped corallium is provided with a large number of calyces. The young are characteristically mushroom-shaped, with a ring of calyces round the margin.

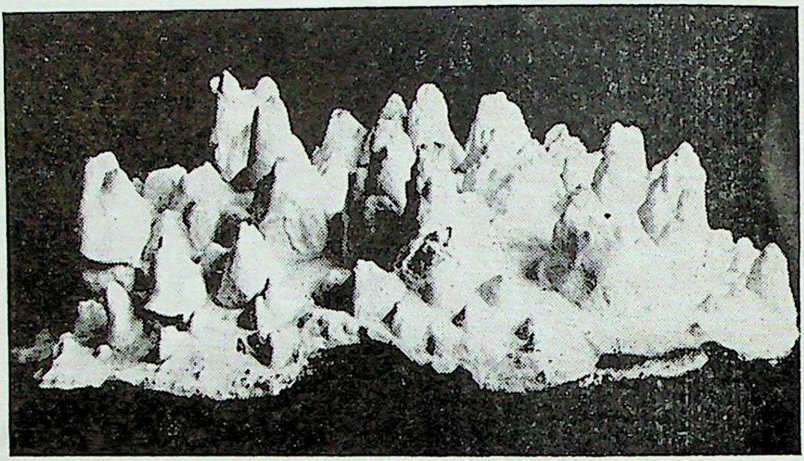

FIG. 9—MONTIPORA EXSERTA: A MASSIVE REEF CORAL.

Antipatharian Corals (*Black Corals or Tree Corals*).—One of the important Orders included under the Sub-class Zoantharia is the Order Antipatharia which includes the so-called Black Corals. The skeleton is plant-like in appearance, consisting of stems (some of which are branched) composed of horny material and bearing small polyps. The tentacles of the polyps are six in number. These horny corals inhabit the deeper tropical waters.

Like the Gorgonians, the Antipatharian Corals have a hard, horny axial support. Some have a long, straight or spirally twisted unbranched stem; some branch in all directions like a shrub, while others branch in one plane, giving rise to a fan-shaped structure. The specimen exhibited in this gallery (*Antipathes sp.*) is a small example of a tree coral, which is one of the commonest shapes assumed by the Antipatharian Corals. The horny axis of these corals is provided with a number of sharp, thorn-like processes, which give them a rough, prickly surface. The horny axis of the stems and larger branches of Antipatharians formed the "Black Coral" of ancient writers.

CORAL REEF AND ATOLLS.

Reef-forming corals only seem to flourish in relatively shallow water in the tropics. Coral islands commonly occur in circular groups surrounding a shallow lagoon, the chief connection of which with the sea is by a channel on the leeward side of the group, the whole group being protected at other places by a barrier reef at varying distances from the shore. Such groups of islands are known as atolls.

Reef corals may occur in the following different forms.—(1) a *fringing reef* extending out to a quarter of a mile from the shore; (2) a *barrier reef*, separated by a lagoon of considerable depth and width from the shore; and (3) an *atoll*, or circular reef, encircling a lagoon of water and not enclosing an island. The largest and most famous of the barrier reefs is the Great Barrier Reef extending to a length of about 1,200 miles off the North-east coast of Australia.

There are various theories which have been put forward to explain the orign of coral reefs. Darwin suggested that the growth of corals began on a sloping shore and that as the shore sank or subsided, this became a barrier reef and later an atoll, when the land was completely submerged. An atoll was formed by the gradual subsidence of an original single island. Coral would grow and form a reef in the shallow waters round its shores, and after the whole has finally submerged, this ring of coral would continue to grow and form the ring of islands.

Later, Murray suggested that corals growing on elevated points of the sea bottom formed circular reefs which grow most rapidly at the edge, dying off at the centre, and dissolving away in sea water, thus forming the lagoon. Neither of these theories seems, however, to fit all the facts.

Wood-Jones has suggested that whereas the original reef was formed probably as supposed by Murray, the action of wind and the killing of the living coral by deposition of silt play a part in the formation of atolls rather than the dissolving away of the dead coral.

Daly propounded another theory which assumes the withdrawal of water to form the great icecaps of the last glacial period lowered the sea about 200 feet below its present level, and various terraces were then cut or islands levelled by wave action. Later, with rising temperatures, corals began growing and reefs were built up with the gradual rise in the sea level as the ice melted. It has been estimated that all existing reefs could have grown only during the last 10,000 to 30,000 years.

In addition to corals, particularly the Madreporarian calcareous corals, algae of the Nullipore and Lithothamnion groups often contribute largely to the building up of reefs and atolls. Many kinds of animals also live habitually in or among corals and every reef harbours its characteristic reef fauna of miscellaneous forms including a host of marine animals, especially invertebrates.

A series of photographs illustrating coral reefs, particularly from the Pamban area in the Gulf of Manaar, are exhibited in this gallery.

Phylum CTENOPHORA.

(*Comb Jellies.*)

In the earlier systems of classification, this group was treated as a subphylum, under the phylum Coelenterata, as they show some resemblance to jellyfishes, but they are now regarded as a separate phylum, as they are quite distinct in their structure and biology. They are commonly known as "Comb jellies" because of the comb-like plates on the body. They are biradially symmetrical, free-swimming marine animals, with transparent, gelatinous bodies. They resemble the Coelenterates in many respects, but differ from them markedly in possessing eight rows of comb plates (ciliary organs serving for locomotion), in the presence of a sensory organ on the aboral side (i.e., on the side away from the mouth) and in the absence of stinging cells or nematocysts. The entire interior of the body between the digestive tract and the other body structures is filled with a gelatinous substance, the mesoglea. Ctenophores occur plentifully in the warmer seas, and found mostly in surface waters, through a few species are deep-sea forms. Many species are luminescent. This phylum is represented among the exhibits only an explanatory diagram, as actual specimens of this group are difficult to procure and preserve as museum exhibits.

Phylum PLATYHELMINTHES.

(*Flat Worms.*)

The Platyhelminthes, or flat worms, constitute a large group of relatively simple and lowly organized animals, which have a common plan of bodily organization, however widely they may differ in their external appearance, habits and life history. They are usually much flattened and without true segmentation, although the bodies of tape worms have a jointed appearance owing to their bodies being built up of a string of reproductive units. Many species are free living, inhabiting freshwater or salt water, or, more rarely, damp soil, but the group also includes many parasitic worms such as the liver flukes and tape worms. Many of the parasitic flat worms exhibit complicated life histories and live in different kinds of animals at different stages of their development. Suckers and hooks for attachment are frequently present in the parasitic flat worms.

This phylum is broadly divided into three classes: (1) the Turbellaria, or free living flat worms, which inhabit fresh or salt water or moist places on land (Planarians); (2) the Trematoda, including the Flukes wrich are either external or internal parasites; and (3) the Cestoda, or the tape worms which are intestinal parasites in vertebrates.

Class TURBELLARIA.

(*Free-living Flat Worms.*)

The Turbellarians, or free living flat worms, are for the most part small creatures and those that are not actually inhabitants of the sea or freshwater live in damp situations. They have a soft, delicate, flattened, leaf-like and more or less oval body and attain only a small size. The front end of the body is especially sensitive and generally bears eyes and sometimes also a pair of tentacles. Many marine species are beautifully coloured, but unfortunately the natural colour disappears almost immediately on preservation in spirit.

Movement among the Turbellaria is generally of two types, creeping and swimming; but most Planarians, although for the most part aquatic, cannot be said to swim in the strict sense. They move along the substratum or the surface film in a peculiar gliding manner which is effected by means of the constant beating of the cilia covering the pidermis. Some species, however, swim very well and in a few forms the whole body executes serpentine movements like an active leach.

The Turbellaria are mostly carnivorous worms feeding upon small worms, crustaceans, insects; insect larvae and even molluscs. The freshwater Planarians prey upon earthworms, aquatic beetles and pond snails. Land Planarians have been observed to feed on land snails. They engulf their food by enclosing it in the everted pharynx, but a few merely suck up small particles by means of a muscular pharynx which is not capable of eversion. In some cases the digestive juice is poured on to the food before it is engulfed, thus making swallowing easier. Both asexual and sexual methods of reproduction are known in this group and Planarians possess great powers of regeneration of lost parts.

A few specimens of marine Planarians and one of a land Planarian (*Bipalium* sp.) are exhibited. The real colour of these specimens has disappeared owing to preservation in spirit.

Class TREMATODA.

(*Flukes.*)

The Trematoda, which includes the liver flukes and other allied worms known as flukes generally, are all parasitic, mostly in the bodies of vertebrate animals. They usually bear a sucker about the mouth, and one or more additional suckers on the ventral surface. Their food consists of the tissues or body fluids of the host animals which are sucked in by the action of the muscular pharynx.

This Class is divided into two major groups, which not only differ from each other in structure, but also undergo quite different types of life histories. All are parasitic, but the members of the first group—Order Monogenea—inhabit only one host and are ectoparasitic—that is to say, they live on or near the external surface of their hosts and have simple life histories, while the second group—Order Digenea—are endoparasitic, that is to say, they are internal parasites and found in the gut or other organs such as the liver of their hosts and their life histories are complicated, often taking place in more than one host. Economically the endoparasitic forms are more important.

Order MONOGENEA.

(*Ectoparasitic Flukes.*)

The forms included in this group are chiefly ectoparasites of fishes, amphibians and reptiles, but some infest the mouth cavities and urinary bladders. The posterior end of the body bears a well developed adhesive organ, with one or more suckers often with chitinous curved hooks, which serve for attachment. The parasite feeds by sucking nutritive juices from the tissues of the host. Unfortunately this group is not represented by any actual exhibited specimens in this gallery.

Order DIGENEA.

(*Endoparasitic Flukes.*)

These are internal parasites of vertebrate animals having complicated life histories in which one stage at least is passed in an invertebrate host—usually a mollusc. Various species infest particular parts of the digestive tract, lungs, urinary bladder or blood vessels.

Specimens of a few species such as *Gastrodiscus secundus*, *Amphistoma* sp. and the bovine liver fluke, *Fasciola gigantea* are exhibited. But the best known examples are perhaps the sheep Liver Fluke, *Fasciola hepatica* and the Blood Fluke, *Schistosoma*. Explanatory diagrams illustrating the life histories of both these forms are exhibited.

Life history of the Liver Fluke (*Fasciola hepatica*).—The Liver Fluke is a flattened, leaf-shaped animal and is hermaphroditic, i.e., both male and female sex organs are found in the same individual, but cross-fertilization appears to be the rule in this group and copulation has been observed to take place between two different individuals. Each individual is capable of producing about five hundred thousand very minute eggs. These eggs pass through the bile ducts of the host into the alimentary canal and from there to the exterior through the excreta. If the eggs fall on dry ground they generally die, but if they happen to fall on damp vegetation or in water, they hatch out into small ciliated larvae known as the *Miracidium*. These swim about in the water or on the surface film of moisture on damp vegetation for about ten to twelve hours, and if they fail to come in contact with a freshwater shell (*Lymnaea* sp.) within this period, they perish; but those which are lucky enough in finding a snail, bore their way into the tissues of the snail; the miracidium larva sheds its ciliated skin and bores its way deeper in, usually into the digestive gland, where it undergoes great changes in shape and structure, swelling up into a sac-like body called the *sporocyst* within which are developed small larvae called *rediae*, which in turn produce further *rediae*. The *rediae* finally give rise to certain heart-shaped bodies, each with a long, flexible tail. These are known as *cercariae*. The *cercariae*, when mature, migrate outwards and escape from the body of the snail. Soon after their escape, each *cercaria* secretes a cyst around itself and within the cyst it undergoes further development until it develops into a minute, adult fluke. If these cysts are swallowed by a sheep when it is eating grass or drinking the water where they occur, the cyst is dissolved by the digestive juices of the sheep, and the young flukes which are liberated bore their way through the wall of the intestines and enter the body cavity of the host. After about three days they infect the liver, passing through the bile ducts. In the liver and bile ducts of the sheep they grow into maturity, developing into the adult flukes. The life cycles of the liver fluke thus consists of an alteration of generations, a sexual phase in the sheep alternating with an asexual phase in the body of the snail.

When sheep are infected by liver flukes, the liver becomes seriously affected and its functions are interfered with. The sheep is said to suffer from, " liver rot "; it becomes dropsical and suffers from great muscular weakness. The disease can be effectively prevented by systematically destroying the freshwater snails in which they undergo their larval stages. This is done either by draining the pastures so that snails cannot survive, or by introducing ducks on the pastures, as snails are largely eaten by ducks.

Schistosoma (or *Bilharzia*) *haematobium* is an important species of Blood Fluke, common in countries around the eastern shores of the Mediterranean, Southern Asia and many parts of Africa. They are found in the abdominal veins of the host, particularly in the portal vein.

The eggs of the worm, which are oval, with a stout spine at one end are carried to the small blood vessels on the surface of the urinary bladder. By means of the sharp spine they penetrate to the wall of the bladder and are passed out with the urine. This causes bleeding from the wall of the bladder and the urine is bloody. The larval stages of this worm are passed in the bodies of freshwater snails, where the mature *cercariae* are liberated into the water in which the snails live. These *cercariae*, if they happen to find their way into the body of a human host, develop there into the adult worms. Infection may occur either by drinking the contaminated water or by bathing in it, since the *cercariae* are capable of penetrating the skin and migrating through the body. It has been observed that besides man, several species of monkeys and rodents may also be infected with this worm.

Class CESTODA (or CESTOIDEA).

(*Tape worms.*)

This Class includes the tape worms which are among the best known examples of flat worms, and are also economically important, as several of them infest man. They are mostly slender, elongate, and ribbon-shaped with a flat body usually made up of many short sections; hence the popular name "tape worm". There is no mouth or digestive tract in these worms, the food being absorbed directly through the body wall. Tape worms are found as intestinal parasites in a great variety of vertebrate animals. A few tapeworms have a simple, unsegmented, leaf-like body like the liver fluke, but the "segments" or "sections" of the longer and better known types of tape worms are called proglottides and each proglottis is, in many respects, a complete flat worm in itself, in that it contains a full compliment of the reproductive male and female organs and parts of the excretory and nervous systems which are common to all the segments.

A specimen of the dog tape worm, *Dipylidium caninum,* and one of *Taenia* sp. from the intestines of the elephant, preserved in alcohol, are exhibited. But among the tape worms that infest man, *Taenia solium* is perhaps the commonest species and an explanatory diagram showing stages in the development of the cysticercus larva of this human tape worm is exhibited.

The Common Tape worm, Taenia solium.—This is a long, ribbon-shaped worm which may reach a length of fourteen feet One end of the worm is attached to the inner wall of the intestines of man by means of a number of fine hooks set on its small head or scolex. This long, ribbon-like body of the tape worm lies free in the cavity of the alimentary canal, with the head alone securely attached to the intestinal wall. The worm absorbs the liquid food material directly through its thin body wall. The body may reach a length of several feet and may be composed of as many as 850 " segments " or *proglottides.* Each *proglottis* produces both the sperm cells and egg cells, and as these become mature, the hinder segments drop off one by one and pass out of the alimentary canal of the host with the excreta. The eggs get fertilized and the fertilized eggs develop into tiny embryos with six hooks each; the mature segments at the extreme hind end of the tape worm contain a large number of such embroys. As the mature proglottides become detached and pass out of the body of the host with the faeces, these embryos contained in such *proglottides* remain alive for some time, but eventually they die and disintegrate, unless they are eaten by another secondary host, which is usually a pig. In the stomach of the pig, the egg shells surrounding the embryos are digested away and the free embryos are released. By means of its six hooks, it rapidly bores its way through the wall of the gut and enters the blood stream. After passing through the heart, they are carried to the muscular tissues where they become encysted. Here they greatly increase in size and develop into a rounded, bladder-like sac filled with fluid. In this stage the parasite is called the *cysticercus* or " Bladder-worm ". At one point on the surface of the bladder the wall invaginates and at the bottom of the invagination a small head or *scolex* resembling that of the adult worm in all respects develops. Later, when the head is fully formed, it is everted so that the suckers and the rows of hooks at the front end—all come to occupy the same positions as in the adult worm. Pork infected with such encysted bladder worms may be readily recognized by its spotted appearance and is known as " measly pork ". If such infected pork is eaten by man without being sufficiently cooked to kill the parasites, the young tape worms reach the intestines of man where the " bladder " parts of these young worms are digested away, but their minute heads attach themselves securely to the walls of the alimentary canal by means of the hooks and suckers, and develop into the many jointed adult worm by a process of budding. The intermediate stages in the life cycles of some species of tape worms are passed in animals other than pigs.

Man forms the intermediate host for some tape worms and the final host for others, and in the case of at least one species he may play either role. The " Hydatids " which sometimes cause enormous swellings in various parts of the body, are huge, multiple bladder worms, produced by internal budding from the originally simple bladder worms of *Echinococcus granulosus*, a small tape worm, the final host of which is the dog. The adult tape worm most commonly found in man are the beef tape worm (*Taenia solium*) with the pig as its principal intermediate host, and the fish tape worm (*Diphyllobothrium latus*) with the fish as its intermediate host.

Tape worms give rise to far more severe symptoms in children and invalids than in healthy adults. The symptoms include nausea, abdominal pains, nervous disorders resembling epileptic conditions and anaemia. In order to prevent infection, all meat, especially pork, must be carefully inspected and if it is found to be " measly " it must be rejected, or it must be so thoroughly cooked that there will be no chance for any of the encysted bladder worms to survive.

Phylum NEMERTINEA.

(*Ribbon Worms.*)

The Nemertinea, or Ribbon worms are slender, elongate, cylindrical or flattened, vermiform animals, extremely elastic and capable of great elongation and contraction. Some species may attain a length of several yards when fully extended. The body is soft and unsegmented. They possess a ciliated integument and an eversible proboscis lying in a sheath above the alimentary canal. They are variously coloured, some species being red, brown or yellow, while others are green or white; some are uniformly coloured, while others are striped or cross-banded. Most Nemerteans are marine, living closely coiled beneath stones, among sea-weeds or in burrows in rocks or mud between tide marks, but some inhabit deeper waters. A few are pelagic, an a few live in freshwater or damp places on land. The land and fresh-water forms are generally small and inconspicuous and much less numerous.

This group is rare on the Madras Coast, and only a small, somewhat flattened and contracted flesh-coloured specimen is reported to have been collected by Mr. Crichton in the Adyar backwater in 1940.

One species, *Eupolia hemprichi*, is common in and around Kruasadi Island in the Gulf of Mannar, where they are found on stones especially on the south side of Krusadai Island. The worms are slender and extremely contractile and sometimes over 100 cm. in length, white in colour, but marked dorsally with a dark transverse streak close behind the front end and followed a little further back by a somewhat wider dark band from which a median dark band extends to the hind end of the body. A dark mid-ventral band is also present. A specimen of this species from Krusadai Island is exhibited.

Phylum ASCHELMINTHES.

This phylum includes several distinct groups of mostly minute or microscopic animals with a slender body which is unsegmented or superfically segmented and covered by a cuticle. The digestive tract is complete, the intestine being usually straight. The anus is situated towards the hind end. Except in the Rotifers, there are no cilia at the front end of the body.

This phylum is rather a heterogeneous group comprising a number of distinct sub-groups of small or even microscopic forms which were formerly regarded as distinct phyla, but are now treated as classes under the single phylum Aschelminthes. Because of their small size, the actual specimens of most of these groups are not suitable for display in the gallery. Hence except for the Class Nematoda which includes the round worms, some of which are of considerable size, the other classes are represented in this gallery only by explanatory diagrams illustrating the structure and appearance of typical members of the respective groups.

Class I—ROTIFERA.

The Rotifers, or " Wheel Animalcules " are minute, often microscopic animals, less than one millimetre in length, which live mostly in fresh water or in damp places especially among mosses. A few are marine. They are attractive in form and colour and are active in their movements. They are solitary and most of the species are free-living, but some are fixed and are encased in protective tubes; and a few are external or internal parasites. They possess vibrating hairs or cilia which are concentrated at the front end and the rhythmic movements of these cilia often give the appearance of rotating wheels in the living condition; hence the popular name " Wheel Animalcules ". They are bilaterally symmetrical animals with a chitinous skin or cuticle. The body of a typical Rotifer consists of a head region in front, an expanded trunk and a narrow, tail-like posterior foot usually movable and often terminating in two slender toes. Each toe bears a cement gland which secretes a sticky fluid serving for the temporary attachment of the animal to some substratum.

Rotifers are world-wide in distribution. They feed mostly on minute algae or even larger aquatic plants, but some are commensal on other animals and a few are parasitic. Rotifers help in keeping the water clean by feeding on organic debris as well as on other organisms. A diagram illustrating the structure of *Hydatina senta*, a typical freshwater Rotifer, is exhibited.

Class II—GASTROTRICHA.

The Gastrotricha includes minute, almost microscopic organisms ranging from 0.07 mm. to 0.60 mm. in length. They are common among algae and bottom debris of freshwater ponds and lakes and at the sea bottom. They possess long, slender and flexible bodies with a flat, ventral surface bearing two longitudinal bands of cilia which serve for locomotion. The arched dorsal surface bears many slender spines. The posterior end is forked and each lobe contains a cement gland for temporary attachment. The mouth is surrounded by bristles and fine sensory hairs. Their food consists chiefly of minute unicellular algae. The Gastrotricha superficially resemble certain species of Ciliate Protozoans. An explanatory diagram illustrating a typical species of this group, *Chaetonotus maximus*, is exhibited.

Class III—KINORHYNCHA (= ECHINODERA.)

The Kinorhyncha are a group of minute marine worms attaining a length of about one millimetre. They are not unlike the Gastrotricha in their general appearance, but with the hinder end either rounded or lobed or provided with tufts of hair. They are usually found in mud and sand at the sea bottom in shallow seas or in the deep sea. The body is encircled by 13 or 14 rings, two of which encase the head which is surrounded by spines and bears a short retractile proboscis. The trunk is encased in the remaining 11 rings of horny cuticle bearing spines at the sides. A diagram of *Echinodera* sp. is exhibited to represent this group.

Class IV—NEMATODA.

This large and important class includes cylindrical, unsegmented, more or less elongated worms, tapered at both ends and without appendages, although teeth or hooks may be present near the front end and sometimes also with small suckers at the hind end for attachment. The body is covered with a thick, hard, resistant cuticle. They possess a complete and permanent digestive tract. Many of these worms are free-living in soil and water, but many others are parasitic in the body fluids and tissues of plants and animals. They are mostly small or minute, but a few species are large and conspicuous and grow to a length of even a metre. Free-living kinds are generally of minute size and are abundant in soil and mosses and among the roots of plants on which some are parasitic. Some are aquatic, either marine or fresh water and are found in sand or mud between tide marks. The eggs are microscopic and are quite resistant to adverse conditions.

Formerly the Nematodes were classed as a separate phylum, the Nemathelminthes which included also the Acanthocephala and the Nematomorpha, the Horsehair worms. But recently, the Nematoda and the Nematomorpha have been included as distinct classes in the phylum Aschelminthes and the Acanthacephala regarded as a separate phylum.

Since the majority of free-living Nematodes are of minute size, only a few parasitic forms which are of any appreciable size are exhibited. Some of these are from man and are pathogenic (disease-producing) while others are from the intestines of domestic animals such as the dog or horse.

The life histories of a few of the more important parasitic nematodes of man, exhibited in this gallery, such as the threadworm, hookworm, whipworm and Guinea worm and the much larger and more familiar roundworm or eelworm, *Ascaris*, are described below. The filarial worm (*Filaria bancrofti*) is illustrated by an explanatory diagram. All these are common human parasites in India. The life histories of the Nematodes are very varied. They may be parasitic or free-living during their whole life, or part of it may be spent parasitically and part may be free-living. In some forms, there is an alternation between bisexual and hermaphrodite generations of which one (not the same for all species) is free-living and the other parasitic. On account of their economic importance a study of the life histories of the various species that infest man and domestic animals is of particular interest, especially from the point of view of public health and hygiene.

Hookworm.—The hookworm disease known as *Uncinariasis* is caused by a small roundworm about half to four-fifths of an inch in length. At the front end, which is bent back more or less like a hook, is the cup-like mouth by means of which the parasites attach themselves to the mucous membrane of the walls of the intestines, where in addition to sucking the blood of the host, they produce poison which affects the host in various ways, causing anaemia and abnormalities of appetite. The eggs of the hookworms pass out of the host through the faeces and the larvae which hatch out from these eggs grow for a few days and then become encysted. In this encysted condition they find their way into another human being usually through the skin, thence into the circulatory system and finally into the intestines where they develop into the adult worms. There are two common species of hookworms—the old world hookworm, *Ancylostoma duodenale* and the American Hookworm, *Necator americanus*, which has been introduced also into parts of Africa and Asia. Male and female specimens of both these species are exhibited. Prevention of the hookworm disease mainly consists in adopting proper sanitation and avoiding contact with soil and water which are contaminated with infected faeces.

Eelworm.—The eelworms are species of large roundworms belonging to the genus *Ascaris*. A common example of this group occurring in man as an intestinal parasite is *Ascaris lumbricoides*. These parasites may be found in large numbers sometimes from one to thousand worms being found in a single individual. In some cases there may be apparently no ill-effects, but they may cause nervousness, irritability, hysteria and even convulsions. This is one of the largest Nematode parasites known, the female averaging about ten inches in length, and occasionally even reaching a length of about one and a half feet. These worms are among the most frequent human parasites. They have a simple life history. The eggs may be washed from the faeces into drinking water or they may become dry and be blown about as dust and become attached to fruit or vegetables. They may thus be taken into the human body through such contaminated water or foodstuff, and soon after they reach the stomach they begin their development. Strong vermifuges such as Santonin are necessary for expelling these worms from the body. Normally they remain in the alimentary canal of the host, but occasionally they may migrate to other parts of the host, such as the throat or other organs, and this may give rise to serious symptoms such as abscesses.

Whipworm.—Apart from the hookworms and eelworms, the whipworm, *Trichiuris trichiura,* is perhaps the most common worm found parasitic in man. The female whipworms which are always far more numerous than the males, are about ten inches long, while the males are a little smaller. The human whipworm is found almost in every part of the world, but is especially well represented in the warmer countries. It infects both man and monkeys. The front part of the body is thin and thread-like, while the intestines and sex organs occupy the thicker posterior part of the body. The eggs are dark coloured, barrel-shaped bodies and are passed out with the faeces of the host. The eggs which contain the developing embroys are very resistant to adverse conditions. Infection occurs as in the case of eelworms and they attain maturity and produce eggs in less than a month after the eggs have been swallowed by a host. Although the whipworm feeds on blood, it does not produce any noticeable ill-effects on the host.

Pinworm or Threadworm.—Another most frequent and widely distributed intestinal parasite of man is the pinworm or threadworm, *Oxyuris vermicularis.* This parasite occurs almost universally in children at one time or another in temperate and tropical countries. It is found in the lower part of the small intestine and in the caecum. The adult females are whitish worms about two-fifths of an inch in length, and are roughly about the thickness of an ordinary pin. The males are only about half as large and have the hind end of the body rolled inwards. The adult female worms filled with the eggs or the free eggs containing coiled embroys which are passed out with the faeces are usually found sticking around the anus in children and cause intense irritation. The resulting scratching and rubbing causes the fingers and finger nails becoming infected with the eggs which may thereby be transferred to the mouth directly or indirectly, thus causing re-infection or they may be transmitted from person to person by unclean hands. Infection may also occur by swallowing the mature egg-filled female worms or by eating vegetables, etc., which have become polluted by the eggs. Apart from the intense itching and irritation they cause around the anus, these worms may sometimes produce reflex nervous symptoms, probably by the secretion of poisonous substances. Two female specimens from man are exhibited.

Filaria bancrofti.—One of the most interesting groups of human parasitic worms are those belonging to the genus *Filaria.* The best known of these worms is *Filaria bancrofti* which causes elephantiasis in man; this is perhaps the commonest form of filarial disease, and is widespread in India and all warm tropical countries. The parasite is a minute, transparent little worm that occurs in human blood and lymph in many tropical and subtropical regions and often extending into temperate climates also. The larval forms that occur in human blood are very minute, about one hundredth of an inch in length. During the day time very few of these are found in the blood-vessels near the surface of the body but as evening approaches these swarm and come to the peripheral circulation (i.e., close beneath the skin). This is a remarkable adaptation in the life history of this parasite, for in order to develop further, they should enter into the alimentary canal of a mosquito and their chances of survival are therefore increased if they came near the surface of the body towards nightfall when mosquitoes are more likely to bite the host and feed on the peripheral blood. In the body of the mosquito they undergo certain changes and make their way through the walls of the stomach into the muscles where they increase in size until they are about one-sixteenth of an inch in length. Later they migrate to other parts of the body and finally to the proboscis from which they gain entrance into the body of another host when the mosquito bites. Soon after entering the circulatory system of the human host the parasites make their way into the lymphatic vessels where they grow and attain sexual maturity, causing obstruction of the lymphatic vessels. One of the most frequent results of the blocking of the lymphatics is an enormous enlargement of the part of the body in which the blocking occurs giving rise to the loathsome disease known as elephantiasis. It is the lower limbs and scrotum that are frequently affected. Another condition resulting from filarial infection is *chyluria* where the urine is milky and coagulates in a short time. Elephantiasis is seldom completely curable, but prevention of the disease can be achieved by active anti-mosquito campaigns. On account of the minute size of the worms, only an explanatory diagram of this species is exhibited.

The Guinea worm.—Another parasitic worm found in the connective tissues of man, but somewhat distantly related to the true Filarid worms is the Guinea worm (*Dracanculus medinensis*). It has been known to man from ancient times and is supposed to be the "fiery serpent" mentioned by Moses. This is a frequent human parasite in many parts of tropical Asia and Africa. These worms creep in the deeper layers of the subcutaneous connective tissues, and normally attain a length of two to three feet, although occasionally they may reach a length of four feet or more. They are only about one and half millimetre in thickness. The female is the only sex of this worm that is certainly known.

When ready to produce the young ones, the female worm is instinctively drawn towards the surface layers of the connective tissues under the skin, especially in such parts as are likely to come in contact with water, such as the arms or the feet and lower parts of the legs. Here it burrows out to the surface often producing serious ulcers. On coming into contact with water, these ulcers eject myriads of these larvae, which undergo their further development in the body of a minute shrimp-like organism known as *Cyclops*. When all the larvae are discharged the adult worm shrinks and dies and gets absorbed by the tissues of the host. The young Guinea worms become fully developed in the body of the *Cyclops* in about four to six weeks and gain entrance into a new human host when unfiltered water infected with *Cyclops* is taken in by the latter.

The Guinea worm, though annoying, is not in any way dangerous, if it is not interfered with. If it fails to pierce the skin and discharge its larvae, it may give rise to painful abscesses. The usual method of extraction of these worms consists in winding out the extruded part of the worm around a stick, and drawing it out a little further every day. Sometimes this method is successful, but more often it results in the snapping of the worm into two even beneath the skin resulting in the liberation of thousands of young worms into the tissues which may cause fever and inflammation and even prove fatal. Prevention of Guinea worm infection is effected by thoroughly filtering and boiling all drinking water. Addition of small quantities of potash also effectively destroys *Cyclops* which is the intermediate host. An entire female mounted specimen of the worm and an explanatory diagram illustrating its location in the arm of the human host are exhibited.

A few other types of Nematode parasites from the intestines of domestic animals, e.g., *Strongylus equinum* from the horse, *Toxocara canis* from the dog, and *Ascaridia galli* from the domestic fowl are exhibited as wet-preserved specimens, mounted in jars.

Class V—NEMATOMORPHA.

(= GORDIACEA.)

These are known as the "Horsehair worms". They are long, hair-like slender worms with a uniformly cylindrical body and bluntly rounded anterior end. They are for the most part parasitic in the bodies of insects in their early larval stages, but when they become adult they pass out and live freely in the water. Adult worms may be often seen wriggling in the water in ponds and lakes and they often appear suddenly and in enormous numbers. This has led to the popular belief that they are long horse hairs that have "come to life" in water. The female deposits the long, swollen, sticky strings of minute eggs on the stems and leaves of aquatic vegetation. Formerly these worms were actually grouped with the Nematodes, but recently they were separated as a distinct Class.

Phylum ACANTHOCEPHALA.

(*Sping-headed worms.*)

The Acanthocephala include peculiar parasitic worms which live as adults in the intestines of vertebrates and as larvae in the bodies of arthropods. The chief distinguishing feature of this group is the presence of a cylindrical, retractile proboscis at the front end, bearing rows of recurved spines which serve for attachment to the intestinal walls. The body is usually flat and rough in life, but cylindrical and smooth when preserved, and is covered with a thin cuticle. Neither the larva nor the adult has an alimentary canal, the food being absorbed directly from the host's intestines. Formerly these were grouped with the Nematoda, but they differ from the latter in the presence of a proboscis and in the absence of a digestive tract. An explanatory diagram alone is exhibited to illustrate this group.

Phylum ANNELIDA.

(*Bristle-worms, earthworms, leeches, etc.*).

The Annelida include more or less cylindrical worms in which the body is composed of a series of similar, ring-shaped segments. Each segment is usually provided with bristles or appendages, or both. This phylum includes the earthworms, marine bristleworms and leeches. Most species of earthworms (Class Oligochaeta) are found in damp soil and fresh water, while the marine bristleworms (Polychaeta) are found mainly along the sea shore. The leeches (Class Hirudinea) occur chiefly in fresh waters or in moist ground. Some Annelids are free-living, but many species live in burrows or tubes, some live as commensals on other aquatic animals while a few are parasitic. Many species of leeches attach themselves temporarily to the bodies of vertebrates.

This Phylum includes four classes, as follows :—

Class 1—Archiannelida.
Class 2—Polychaeta.
Class 3—Oligochaeta.
Class 4—Hirudinea.

Of these four classes, the Archiannelida include primitive worms of very small size, exclusively marine, and are not represented in the exhibited series of Annelids in this Gallery.

The remaining three classes are represented by mounted wet-preserved specimens belonging mostly to South Indian species.

Class POLYCHAETA.

(*Bristle-worms.*)

This Class includes the marine bristleworms commonly found along the sea shore. These worms generally possess feelers or other appendages of various kinds. Each segment bears a pair of lateral lobes (*parapodia*) from which setae or stiff bristles project. A free-swimming larval stage (*trochophore*) is present. These worms are abundant between tide marks and in shallow water in the coastal regions, but a few live at great depths. Some are pelagic, and some species are brilliantly coloured. The free-living Polychaeta are largely carnivorous, but the tube-dwelling species feed mainly on plankton. A few species, mostly found in Krusadai Island and in the Gulf of Manaar area, are exhibited. Some of the more outstanding among these species are briefly described below :—

Chlocia flava (Fig. 10).—This is a particularly striking species of polychaet worm found at Krusadai. It attains a length of about 120 millimetres. Each segment bears a large black spot in the middle line. This is the most distinctive feature of this species.

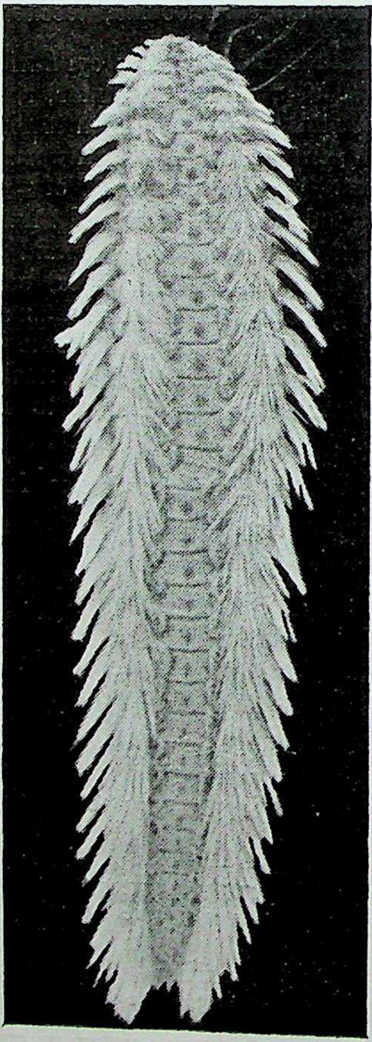

Fig. 10—Chloeia flava : A marine bristle-worm or polychaet.

Eurythoe complanata.—This is a large worm inhabiting crevices in stones and coral rock on the coral reefs. It is quite common in dead coral and possesses thick tufts of glossy spines. When captured, it leaves behind large numbers of these irritating spines in one's fingers. Large specimens are colourless during life, but young ones are said to be brightly coloured (pink, greenish brown or orange-red).

Iphione muricata.—In this species, the body is relatively short and broad, and the dorsal setae are very fine and form large, dense clusters. The head is withdrawn far back between the anterior segments.

Eunice tentaculata.—Specimens of this species are chiefly found among stone and shingle and dead coral. The general colour is a dull greenish grey. Large specimens attain a length of about 130 millimetres.

Onuphis dibranchiata.—This large Eunicid worm is common in the sand below high water mark in the sandy shore on Krusadai Island. The gills are feather-shaped and bifid in this species. Another very long specimen, reaching a length of over two feet, belonging to an unidentified species of *Onuphis* is also exhibited.

Loimia annulifilis.—This is another species of Polychaet worm commonly occurring in the Pamban area, with bushy gills. In life, its colour is variable, being grey or yellowish, with dark brown thoracic bands and ventral shields. According to Fauvel, this is only a colour variety of *Loimia medusa*, distinguished by the tentacles being ringed with purple bands.

Some specimens of tube-dwelling Polychaet worms, such as *Sabellaria* sp., and *Eunice tubifex*, with their tubes, encrusted with commensal organisms are also exhibited. These worms secrete a tube, mostly composed of fine sand grains and embedded in the sandy shore or in the sea bottom. Some tube-dwelling worms can burrow in rocks and shells.

Class OLIGOCHAETA.

(*Earthworms.*)

This class includes the earthworms which have only a relatively few setae or bristles in each segment and these are directly embedded in the body wall of the worms and not borne on paired lateral lobes as in the preceding class. Earthworms are nearly always devoid of tentacles, feelers or other appendages and are mainly terrestrial or freshwater in habit, but a few species inhabit the sea shore.

Earthworms live in burrows and are therefore well protected against enemies and adverse climatic conditions. After dark, they generally emerge from their burrows to fee dand mate. When there is a sudden flooding of the ground due to heavy rain, many earthworms emerge from their burrows and may be seen moving about on the surface. Earthworms are very sensitive to light and mechanical vibrations. Adult earthworms possess the power of regenerating lost parts to a limited degree.

Earthworms have long been known as the "farmer's friend", for in nature, they play a very effective role in aerating the soil and rendering it fertile. In many soils thousands of worms are present per acre and they are of much practical utility in turning over the deeper layers of soil to the top and thus allowing air and water to penetrate. Earthworms are also used as baits for catching fish.

The exhibited series representing this group includes, among others, a small habitat group showing models of the common earthworm in the act of burrowing in the soil, a portion of which is shown in vertical section.

Wet-preserved specimens of a few species of earthworms, common in South India, are exhibited. These include a fine specimen of *Moniligaster grandis* from Naduvattam in the Nilgiris; it is one of the largest of Indian species of earthworms and attains a length of more than 12 inches and a thickness of over quarter of an inch.

Class HIRUDINEA.

(*Leeches.*)

This group comprises the leeches. They are cylindrical or flattened animals in which the body is composed of numerous ring-like segments. They possess enlarged suckers at either end serving for locomotion and attachment, but they have no bristles, tentacles or any other appendages. They differ from other Annelids in the presence of copulatory organs and genital openings.

Leeches are mostly nocturnal creatures and inhabit freshwater or moist places on land. A few occur as external parasites on marine fishes. They move about by looping movements of the body effected with the aid of their suckers. Some leeches are able to swim by rhythmic undulating movements of the body. Leeches are essentially predatory or parasitic in their habits. This group is well known for the blood-sucking habits of some species, such as the medicinal leech. Such leeches attach themselves firmly to the body of the host by means of their suckers and, piercing the skin with their sharp, tooth-like jaws, suck the blood by the action of their muscular pharynx. Leeches are often eaten by various aquatic animals, and are used as fish bait. Wet-preserved speciments of two species of *Hirudinaria* and one of *Disciniscа* are exhibited. These species commonly occur in fresh waters and neighbouring moist localities in South India.

Phylum SIPUNCULOIDEA.

This group includes small, unsegmented, worm-like creatures, popularly known as "Peanut worms". They are commonly found living in the shallow sand or mud or in crevices of empty shells and among rocks on the sea shore. When disturbed, they withdraw the fringed front end of their body and assume a stunted, club-shaped appearance. A few species are slender and even thread-like, but many others are thicker and more robust, in the form of a more or less thick, unsegmented worm with a baggy integument. Large forms may attain a length of about 10 to 18 inches.

When feeding, they extend their tentacles over the sea bottom and capture small, microscopic organisms by means of ciliary movements. Some sipunculids take in sand as they burrow and then digest the minute organisms that may be adhering to the sand.

Formerly, this group was known by the name *Gephyrea*. About four species of sipunculids occur in the Krusadai Island area; of these, a specimen of one species, *Dendrostoma signifer*, is exhibited. This species is found plentifully in blocks of dead coral on Krusadai Island and may attain a length of as much as three centimetres. It bears a bunch of large, plumose tentacles at its front end.

Phylum BRYOZOA.

(*Moss animalcules.*)

This phylum includes small animals popularly known as the moss animalcules. They are also sometimes known as the Polyzoa. A few species are solitary, but many of the Bryozoans form branching colonies, or incrustations, attached to objects in shallow water. Some resemble colonial hydroids and corals in external appearance. Anatomically, however, they are far more advanced than the Coelenterates. The marine kinds are sometimes known as sea mats and lace corals and are found attached to rocks, weeds, shells, piers, submarine cables, bottoms of boats, etc. Most members of this group are marine and live between tide marks and even deeper, at all possible depths. A few species, however, are confined to freshwater; these form delicate, plant-like colonies or gelatinous masses, growing on submerged stones, logs, floating vegetation, etc.

Each individual of the Polyzoan colony possesses a well developed U-shaped digestive tract, with a mouth at one end and an anus at the other end. The front end of the body is in the form of a rounded ridge which bears a circle of ciliated tentacles surrounding the mouth. Food is captured by the action of myriads of fine, vibrating hairs or cilia which are borne on the tentacles. By budding they form calcareous or horny colonies, sometimes erect and branched, sometimes encrusting.

Specimens belonging to a few common South Indian species such as *Cellaria*, *Bowerbankia*, *Pectinatella* and *Membranipora* are exhibited. Of these, the first two are common around Pamban and Krusadai Islands. Specimens of *Membranipora* are commonly washed up on the Madras beach. It is an encrusting form found abundantly on shells and on floating pieces of wood and possesses a calcareous exoskeleton.

There are more than 2,500 species of living Bryozoa, but many more species flourished in the past Geological ages. Their exoskeletons have helped in the formation of massive calcareous deposits and rocks in many Geological strata.

Phylum PHORONIDEA.

This phylum includes slender, worm-like creatures of varying sizes inhabiting the sea bottom in shallow waters. They are sedentary, being attached to the substratum. They may be either found as isolated individuals or densely crowded together so as to cover large areas of the sea bottom. Each individual is encased in a leathery, horny or calcareous tube from the open end of which the tentacles project. The tentacles are arranged in a horse-shoe-shaped row at the front end (*lophophore*). These animals feed by extending their tentacles and capturing minute organisms in the water or on the bottom of the sea by means of the mucus-covered surface of the tentacles. When exposed at low tide, they withdraw themselves into their tubes. Several species are brightly coloured, and when they are crowded together, they may impart a brilliant colour to large areas on the ocean floor.

The systematic position of Phoronids is still uncertain. They appear to have affinities with the Bryozoans and the Brachiopods, but probably they are more nearly related to the Hemichordates (a group of primitive Chordates).

An enlarged diagram illustrating a specimen of *Phoronis buskii* (removed from its tube, and seen from behind) is exhibited to represent this phylum.

Phylum CHAETOGNATHA.

(*Arrow worms.*)

This group comprises small, transparent torpedo-shaped marine animals, popularly known as the Arrow worms. They range in lengthfrom 20 to 70 mm. They are all pelagic and many species figure prominently in plankton collections. The body is cylindrical, with well defined head, trunk and tail regions. The body possesses well marked expansions—the fins. There are two pairs of lateral fins at the middle and towards the end of the trunk and a terminal tail fin. The mouth is surrounded by a lobe on either side bearing a series of sickle-shaped hooks or bristles and this feature accounts for the scientific name of the group, *Chaetognatha*, meaning bristle-jawed animals. They are usually unsegmented, and being transparent, they are popularly known also as " glass-worms ". They feed actively on minute organisms, including diatoms and Crustacean larvae and other planktonic animals, and during life their movements resemble those of darting arrows, hence the popular name " arrow worms ". The Chaetognatna are hermaphrodite, both testis and overy being found in the same individual.

As the actual specimens are small and inconspicuous, this group is represented in the gallery only by an explanatory diagram illustrating *Sagitta hexaptera*—a typical species of this phylum.

Phylum BRACHIOPODA.

(*Lamp shells.*)

The Brachiopoda are a small group of fixed, solitary, apparently unsegmented animals living in the sea at all depths. They bear a superficial resemblance to bivalve molluscs in having then bodies encasbed in an external bivalved shell, but these valves are dorsal and ventral and not lateral (right and left) as if the case of the bivalve molluscs. One valve is shaped like an ancient Roman oil hand lamp, hence the popular name " Lamp shells " for this group. There is usually a thick, fleshy, anchoring stalk, which passes through an aperture in this larger valve, recalling the hole for the wick. The animal attaches itself permanently to the sea bottom by means of this stalk. The actual body of the animal occupies only the posterior part of the space between the shells. The mouth is surrounded by a large, W-shaped mouth groove--the lophophore—lined with long ciliated tentacles which help in procuring small organisms that form the food of the Brachiopods. This phylum is a very ancient one and is abundantly represented by fossil forms since the early Cambrian times. All living Brachiopods are marine, solitary and usually attached.

This phylum is divided into two classes—the Inarticulata, in which the two valves are nearly alike and an anus is present, and the Articulata, in which the two valves are unlike and an anus is absent.

A single specimen of *Lingula* with the shell valves and the long fleshy stalk intact, belonging to the Class Inarticulata, is exhibited. They live between tide marks and burrow in mud or sand with the long, muscular, contractile peduncle.

HALL II.—HIGHER INVERTEBRATES.

(*Mollusca, Echinodermata and Arthropoda.*)

The adjoining gallery is devoted to the remaining three major phyla of Invertebrates—the Mollusca, Echinodermata and Arthropoda. The animals belonging to these groups are in many respects of a highter grade of organization than those of the groups exhibited in the preceeding gallery and many of them possess a very complicated structure.

Phylum MOLLUSCA.

The Molluscan specimens (sea shells, cuttle-fish, etc.) are exhibited in the part of the gallery immediately adjacent to the Coral gallery. The exhibits of Mollusca are displayed both in wall cases and table cases with sloping tops along the entire length of the wall adjoining the Coral gallery, and consist of an almost complete systematic series of Mollusca found in South India. The exhibited material of Mollusca consists of both dry shells and wet preserved ones with the soft parts intact, and belong to species inhabiting the sea, land and fresh water.

Molluscs are soft-bodied animals, protected by an outer covering, usually hard, composed of some form of limy or calcareous material, and without internal skeleton, except in very exceptional instances. Externally, most mollusca possess a head, a ventral creeping organ known as the foot and a dorsal covering, the mantle, which bears and secretes the shell. This protective shell is a leading feature of the group, and into it the animal can generally withdraw, but there are several molluscs without a shell or at most only an internal shell of a more or less rudimentary nature.

Molluscs are very widely distributed and most of them are marine, living in shallow waters along the sea shore, but some are deep sea forms and others are pelagic. Many species inhabit fresh water and brackish water while many others such as the land snails and slugs are terrestrial. Most moluscs are free-living, but some are attached to rocks, shells or wood, and others burrow in sand, wood or rock. A few species float, while molluscs like the squids and octopuses can swim freely.

The study of Molluscs is a fascinating one, as the shells which most of them produce have always been objects of attraction owing to the beauty of form and colour displayed by many of them. The commonest objects found on the sea beach are the shells of these soft-bodied animals washed up on the beach by the waves, and hence shell-collecting as a hobby is very popular with most amateur naturalists.

The Mollusca are broadly classified into five main groups or classes, of widely differing appearance and habits, namely, the Amphineura (the Chitons), the Gastropoda (snails, slugs, whelks, etc.), the Scaphopoda (tusk shells), the Pelecypoda (calms, oysters, scallops, etc.), and the Cephalopoda (cuttle-fish, octopus, squid, etc.).

The chief distinguishing characters of these five classes are briefly outlined below :—

Class Amphineura.—The body is elongated and symmetrical and there are numerous spicules embedded in the mantle. Of the two Orders into which this Class is divided, only one, the Polyplachophora, characterized by the presence of eight shell valves arranged in a linear series, are represented in the Indian waters. These include the Chitons or "Coat-of-mail shells".

Class Gastropoda.—The shell, when present, consists of only one piece, which is usually well developed and spirally coiled, but may be occasionally rudimentary or even absent altogether. This large Class includes the vast majority of snails, slugs, whelks, cowries and other molluscs found in the sea, on the land and in fresh water.

Class Scaphopoda.—The shell is tubular and tusk-shaped The animals usually lie half buried in the soft mud at the sea bottom. This Class includes the tusk shells (*Dentalium*).

Class Pelecypoda.—These possess a bivalve shell, that is to say, the shell is composed of two pieces, right and left, hinged together by a horny hinge ligament at their apices or *umbones.* This Class includes all bivalve molluscs such as ark shells, clams, feather shells, cockles, oysters, scallops, mussels, etc.

Class Cephalopoda.—These have a well developed head and a circle of processes or arms round the mouth; a shell may be present or absent, and when present, may be external or internal. The cuttlebone, a white, brittle, calcareous, elongated structure, which is found frequently washed up on the beach is the internal shell of the cuttle-fish. This Class includes the cuttle-fishes, squids, octopuses, etc., and some of them are perhaps the largest among the Invertebrates, some species of giant squids reaching a length of even fifty feet.

Each of these five Classes includes a number of families, many of which are represented in South India, and representative specimens of most South Indian species belonging to all the above five classes of molluscs are exhibited, more or less in their strict systematic sequence. The more important ones among them are briefly described below, grouped under their respective classes and families.

Class I—AMPHINEURA.

As already mentioned, under this Class, only the Order Polyplacophora or Loricata is represented in the Indian waters, and hence only specimens of this Order are exhibited. They are popularly referred to as Chitons or " Coat-of-mail shells ". They are characterized by the presence of a flat, elongated foot with which they crawl slowly on the substratum, a distinct head and eight shell valves on the dorsal side. They live among rocks, generally between tide marks, and may often be seen adhering to the sides of rock pools in reefs. The families Mopaliidae, Cryptoplacidae, Chitonidae and Ischnochitonidae are represented on South Indian coasts. The species most commonly met with at Krusadai is *Ischnochiton herdmani*—growing to about 1½ to 2 inches in length. Another species common around the Madras Coast is *Acanthochitona mahensis*, with tufts of glassy spicules on the upper surface of the girdle surrounding the shell valves. Dry and wet preserved specimens of many of these common South Indian species are exhibited.

Class II—GASTROPODA.

This is a very large and important Class of Mollusca including the snails, whelks, cowries, limpets, sea hares and their allies. A shell is usually, but not invariably present. When present, it consists of a single piece and is therefore said to be univalve. It is usually spirally coiled. The anatomy of the Gastropoda is characterized by marked asymmetry in the adult state caused by a process known as torsion. A coloured sketch to illustrate torsion in the Gastropoda is exhibited in the wall case at the commencement of the Gastropod series.

According to the older, but better known classification, the Gastropoda are broadly divided into two main groups, the Streptoneura and the Euthyneura. The former are bisexual, and have the nervous system thrown into a figure-of-eight, while the latter are hermaphrodite, in which the main nerve trunks have become secondarily straightened out and assumed a parallel condition. Each of these sub-classes is in its turn divided into two orders, the former into Aspidobranchia and Pectinibranchia and the latter into Opisthobranchia and Pulmonata. The Aspidobranchia include the most primitive Gastropods in which the nervous system is only very slightly concentrated, while the Pectinibranchia include the more advanced Gastropods with a more concentrated nervous system. These two orders comprise the vast majority of marine and fresh water shell-bearing Gastropods. The Opisthobranchia are also marne, but exhibit a marked tendency to the reduction of the shell which is either altogether wanting or at most only imperfectly developed and often internal. The Pulmonata include mainly land or amphibious molluscs with adaptation to aerial respiration.

The classification outlined above is the older classification, but the more modern classification followed by Thiele and other authors, in which the division into the different Orders is based mainly on radular characters, is the one that is generally accepted to-day.

The following is an outline of this more up-to-date classification :—

Class Gastropoda—

Subclass Prosobranchia—

Order Archaeogastropoda (including the families Haliotidae, Fissurellidae, Patellidae, Trochidae, Turbinidae and Neritidae). Primitive forms in which the gill filaments are flattened.

Order Megagastropoda (including Turritellidae, Cerithiidae, Janthinidae, Doliidae, etc.).

Order Stenoglossa (including the families Muricidae, Buccinidae, Volemidae, Nassidae, Olividae, Vasidae, etc.).

Order Toxoglossa (including the families Turridae. Terebridae and Conidae).

Subclass Opisthobranchia—

Order Pleurocoela (Tectibranchia) (including the families Hydatinidae, Bullidae, etc., and also the Sea hares, belonging to the family Aplysiidae, with the shells mostly fragile or rudimentary and internal).

Order Sacoglossa (including the families Polybranchiidae and Elysidae; these are forms without shells, with simple, flattened bodies or with leaf-like appendages).

Order Acoela—Suborder Nudibranchia (including the majority of shell-less molluscs known as Nudibranchs, such as Doriids, *Kalinga ornata*, etc.; true gills are absent but secondary gills in the form of exposed tufts are present).

Subclass Pulmonata (including the majority of land molluscs and many fresh water shells, in which true gills have disappeared, their function being taken over by the modified wall of the mantle cavity).

Order Basommatophora (including the family Siphonariidae, etc.).

Order Stylommatophora (including the families Onchidiidae, Pleurodontidae, etc,).

Subclass PROSOBRANCHIA.

The exhibited specimens of the Gastropod molluscs consisting of both dry shells and wet-preserved specimens are arranged more or less in the sequence followed in the above classification, grouped under their respective families. A brief account of the various main types of Gastropod molluscs represented in South India and exhibited in this gallery is given below, family by family, grouped under their respective Orders :—

Order Archaeogastropeda.—This Order includes primitive forms such as the Limpets (Patellidae), Key-hole Limpets, (Fissurellidae) and Ear shells (Haliotidae). In Limpets, the shell is conical and forms a stony cap under which the animal lives secure. The Limpets have a broad, sole-like muscular foot which assists them greatly in clinging to the rocks very tenaciously. They feed upon smaller sea weeds. They live between tide marks and are usually gregarious, and migrate locally and return to the same spot periodically.

The. Key-hole Limpets (Fissurellidae) resemble the true Limpets in the shape of the shell, but the shell has a perforation at the apex or a slit in the front margin. The Indian species belong to the genus *Diodora*. The Slit Limpets (*Emarginula*) are rarer and live below tide mark.

The Ear shells (Haliotidae) (Fig. 11) may be found living under boulders at extreme low tide at Pamban and Krusadai. This species (*Haliotis varia*) is quite small, while in France, Japan and other countries the shells attain a much larger size. A pair

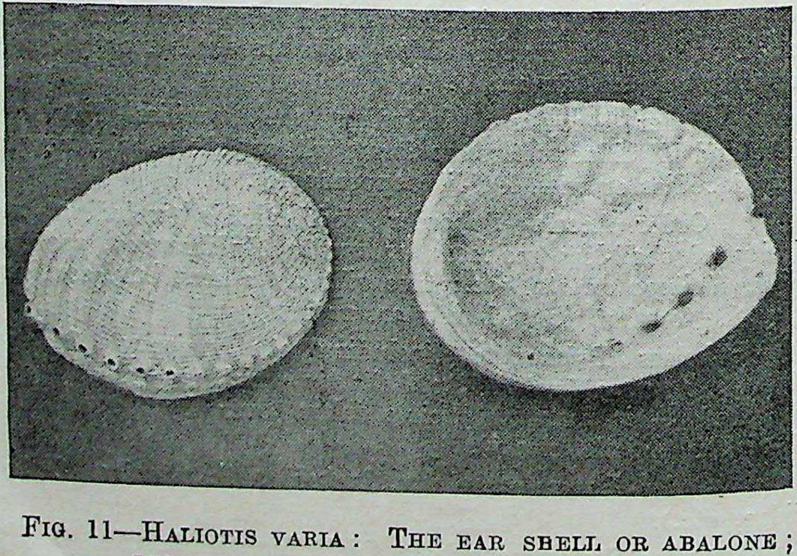

FIG. 11—HALIOTIS VARIA : THE EAR SHELL OR ABALONE ; LEFT, OUTER VIEW ; RIGHT, INNER VIEW.

of exceptionally large shells of some foreign species are exhibited. Pearls are not uncommon in the mantle of some shells of this family. The flesh of *Haliotis* is also highly valued as food (abalone). The shell bears a row of holes through which processes of the mantle project during life.

The Top shells (Trochidae) (Fig. 12) and the Turban shells (Turbinidae) are also common in the littoral regions. *Turbo intercostalis* is a common species of Turban shell found abundantly on the reefs at Pamban. The large, characteristic calcareous operculum of this species is known by natives as "*Ravanamuzhi*" in Tamil. These shells are found attached to stones and boulders between tide marks. One of the most beautiful of our common Trochids is the little button shell, *Umbonium vestiarium*, which exhibits infinite colour variation and is found in large numbers among water weeds in shallow water on mud flats and sandy shores, burrowing in the mud.

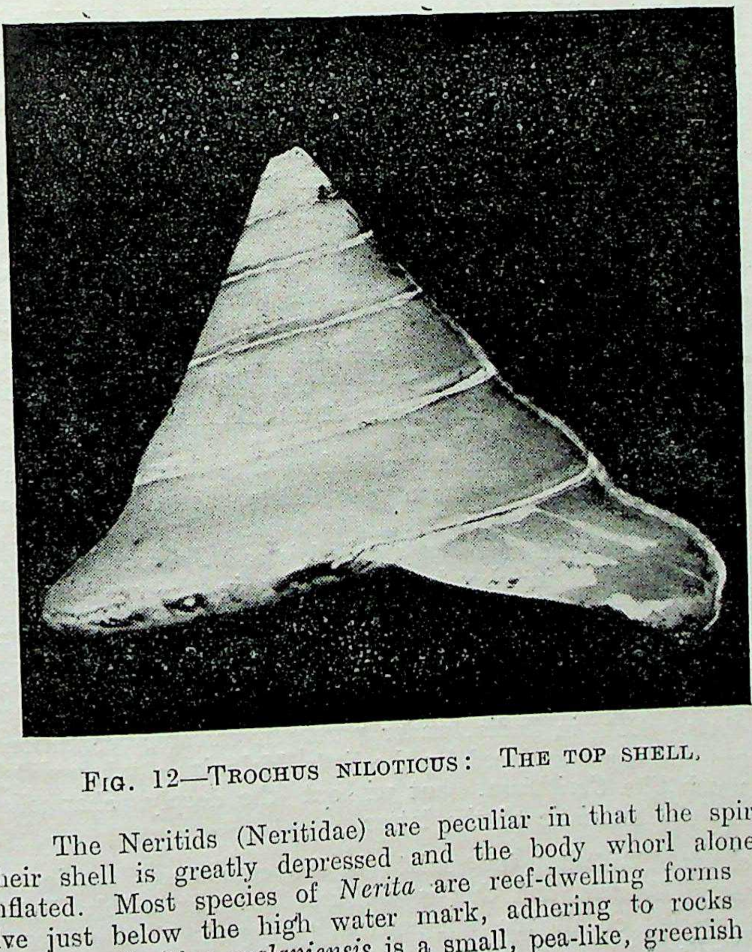

FIG. 12—TROCHUS NILOTICUS: THE TOP SHELL.

The Neritids (Neritidae) are peculiar in that the spire of their shell is greatly depressed and the body whorl alone is inflated. Most species of *Nerita* are reef-dwelling forms and live just below the high water mark, adhering to rocks and stones. *Neritina oualaniensis* is a small, pea-like, greenish shell found in brackish water on mud flats often in association with *Umbonium*. A third genus, *Septara* lives on the banks of streams high up where it is kept damp only by spray. . The shells of Neritids, as a rule, are massive, and are able to survive the rigorous conditions of the littoral zone.

Order Megagastropoda.—This great group includes, several well known families of marine, freshwater and brackish water molluscs.

The *Cyclophoridae* include land shells which vary widely in form and size, ranging from a depressed, disc-like shape to an elongate, tower-staped from, but mostly globularly top-shaped. The shell is usually thick and the outer lip is normally thickened and everted into a prominent rim. The animals in which the mantle cavity is modified into a lung, are terrestrial.

The *Viviparidae* and the *Ampullariidae* include purely freshwater forms. *Vivipara bengalensis* is the common banded pond snail of India. The *Ampullariidae* includes the more common and larger Apple snail, *Pila globosa*. *Pila* has an air-breathing organ in the form of a rudimentary lung in addition to a gill for use in water. This enables it to live in comfort for some time even outside water. It can also remain hidden in soft mud and still obtain air by pushing upwards to the surface of the mud the end of a long, muscular tube.

The *Littorindae*, popularly known as the Periwinkles, are found on rocky shores in all parts of the world. They are semi-terrestrial in habit. The Indian species are often found clinging to stems of mangroves high up so as to be reached only by the sea spray at high tide. In these molluscs, the internal surface of the mantle is modified into a sort of a rudimentary lung.

The *Cerithiidae* (Horn shells) also show a tendency to migrate from sea to land. They have long, screw-shaped shells and are often gregarious, and found in saline backwaters. Two large species of Horn shells, *Terebralia palustris* and *Telescopium telescopium*, are found in abundance crawling in the mud in the mangrove swamps of the Krishna and Godavari deltas, more often out of water than in it, while the much smaller shell, *Cerithidea fluviatilis*, is extremely common both at Ennur and Pamban, where they are found plentifully in brackish water on mud flats. But in India, under purely freshwater conditions, the horn shells are replaced by the little *Melania*, a tuberculated shell much like *Cerithium*, but without the deeply channelled aperture characteristic of the latter.

Melania (*Striatella*) *tuberculata* is the commonest species of the genus *Melania*, and this is perhaps the most widely distributed species of all the non-marine gastropods that occur in South India.

The *Vermetidae* (*Worm shells*) are particularly aberrant in habit. In the adult state, they are always found attached to rocks or embedded in sponges. In early life they are free and their shells are regularly spiral, but after they settle down, the spiral, as it grows, becomes loose and irregular. The foot becomes reduced. *Vermetus and Siliquaria* are two of the common South India genera. *Vermetus* cements its tubes to rocks, while *Siliquaria* lives as a commensal on sponges.

The *Architectonidae*, including the Staircase shells, are shaped like a broad, depressed cone, with a widely open umbilicus beneath, giving the appearance of a widening spiral staircase. The shell has a handsome low spiral, and the body whorl is angular at its outer edge. They are fairly common on sandy beaches around our coasts, especially after storms.

The *Turritellidae* (Screw shells) have long, elegantly tapered shells. They live in moderately deep water in muddy sand. Their shells are often washed up on the beach, and are quite common on the Madras and Pamban coasts. As the shell grows longer, the narrow disused portions of the shell towards the apex is partitioned off internally.

The *Strombidae* (*Wing shells*) include some of the largest and most brightly coloured species of gastropod shells. *Strombus* has a wing-like expansion in the shell, while in *Pterocera*, this wing is prolonged into processes. They are remarkably active gastropods. The foot is narrow and arched, armed with a long claw-like horny operculum. They progress by a sort of leaping movement. They are reputed to be carrion feeders.

The *Calyptraeidae* include the cup-and-saucer limpets (*Calypiraea*) and the slipper limpets (*Crepidula*). The former are small and conical, the latter, oval and much flattened. In both, an internal plate occurs, the remains of the original spire of the shell. They generally adhere to stones or to other shells. Slipper limpets sometimes increase so prodigiously as to prove a menace to the oyster industry.

The *Naticidae* are active sand-burrowing forms. In *Natica* proper, the shell is strong, handsome and highly polished, usually almost globular, but in some cases (*Sinum*) the body whorl is so flattened and expanded as to appear almost ear-shaped. The spire is small and obsolete. *Albula mamilla* is a white, polished shell common on sandy shores where they live upon the burrowing bivalves that abound there. Having found a shell, *Natica* seizes it and settles down to bore a hole through one of the valves. When completed, the long retractile proboscis is inserted through the aperture and the flesh of the victim eaten out. The peculiar egg-mass of *Natica*, in the form of a broad spiral ribbon, is quite common at times on the mud flats and in shallow water at

Ennur, Adyar, Pamban and Tuticorin; the eggs are minute and so intimately mixed and agglutinated together with sand grains that they practically look like sandy ribbons.

The *Janthinidae* include the Violet snails. They are purely pelagic and are found floating on the surface of the sea and are often cast ashore alive. The foot is small and attached to it is a long, forthy-looking floot composed of bubbles entangled in a transparent secretion of the foot. They are gregarious and float about in shoals feeding upon oceanic jellyfishes. Some species attach their egg capsules to the under side of the float.

The *Cypraeidae* (Cowries) are among the best known of Indian shells, noted for the beauty and variety of their colour and colour patterns, and the exquisite polish on their shells. The young shell is elongated with a prominent, conical spire, but in the adult shell, the spire gets absorbed inside and the shell comes to have a narrow linear aperture with usually toothed lips. The foot is without an operculum. The cowries live on rocky ground particularly in and about coral reefs. They are often found hiding under boulders at low tide and are apparently limited to shallow water. The little Money Cowry (*Cypraea moneta*) is abundant on the reefs near Pamban. It is deep yellow in colour. Among the other numerous common South Indian species exhibited in this gallery, mention may be made of *C. ocellata*, with tiny eye-like spots, the Tiger Cowry (*C. tigris*) with large, bordered spots, the Black Cowry (*C. mauritiana*) a most elegant species with a dark chestnut, reticulated colour pattern and the Arabian Cowry (*C. arabica*), with hieroglyphic markings on the shell.

Other large and beautiful marine shells are included in the family *Cymatiidae* (*Tritonidae*) (*Triton shells* (Fig. 13). They live in shallow water on the rough sea bottom. The larger helmet shells, included in the family *Cassididae* are rare and are usually found about eight to ten fathoms deep on the pearl banks of the Gulf of Mannar. *Cassis rufa*, with a deep reddish brown shell, is found in the Laccadive Islands. Helmet shells are used for cameo-carving.

The *Doliidae* include the Tun shells. These are large, strongly inflated, more or less globular or ovoid shells generally with strong, spiral ribs, and are common on the Madras beach and other sandy shores on the East Coast. They are rather thin and fragile shells and easily get broken when washed ashore.

The *Pirulidae* (Fig. 14) *or Ficidae* include the Fig. shells. They are more or less pear-shaped and are similar in habits to the Tun shells—living on sandy bottom not far below the low tide mark. To enable them to crawl rapidly and comfortably over soft unstable sand, the foot in these two families is exceptionally wide when fully expanded, forming a flat sole.

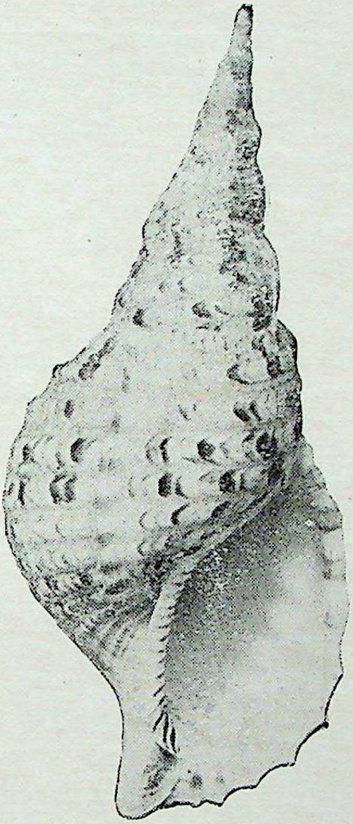

FIG. 13—CYMATIUM VARIEGATUM: A LARGE TRITON SHELL FROM THE LACCADIVES.

The *Bursidae* include the Purse shells which resemble the Tritons in general appearance, but differ from them chiefly in the presence of a posterior as well as an anterior canal in the margin of the aperture. The shells of this family generally bear rows of spines or tubercles. They are whelk- like shells found among rocks on reefs.

Order *Stenoglossa.*—In this Order are ground together most of the remaining families of marine shelled gastropods such as the *Muricidae*. *Buccinidae*. *Vasidae*, *Harpidae*, *Olividae*, *Volutidae*, etc.

The *Muricidae*, comprising the Purples, Venus' combs, etc., has a world-wide distribution. The handsome, long-spined, *Murex tenuispina* (Venus' comb) is frequently brought up in nets by Madras fishermen, and live in moderately deep waters. These shells are ornamented frequently with prominent varices armed with sharp spines. The basic form of the shell is fusiform. The foot is abruptly cut off in front. The Muricids are all carnivorous, living free on the bottom; they feed mostly on bivalves particularly on pearl oysters. The largest of all Indian Muricids is *Murex ramosus*. This shell is found associated with the larger Horned Helmet shells (*Cassis cornuta*) in deep water (10 fathoms). The Purples (*Thais*, *Drupa*, etc.), are littoral shells of small size found on all rocky coasts. The largest Indian species of Purples are *Thais bufo* and *Thais rudolphi*—

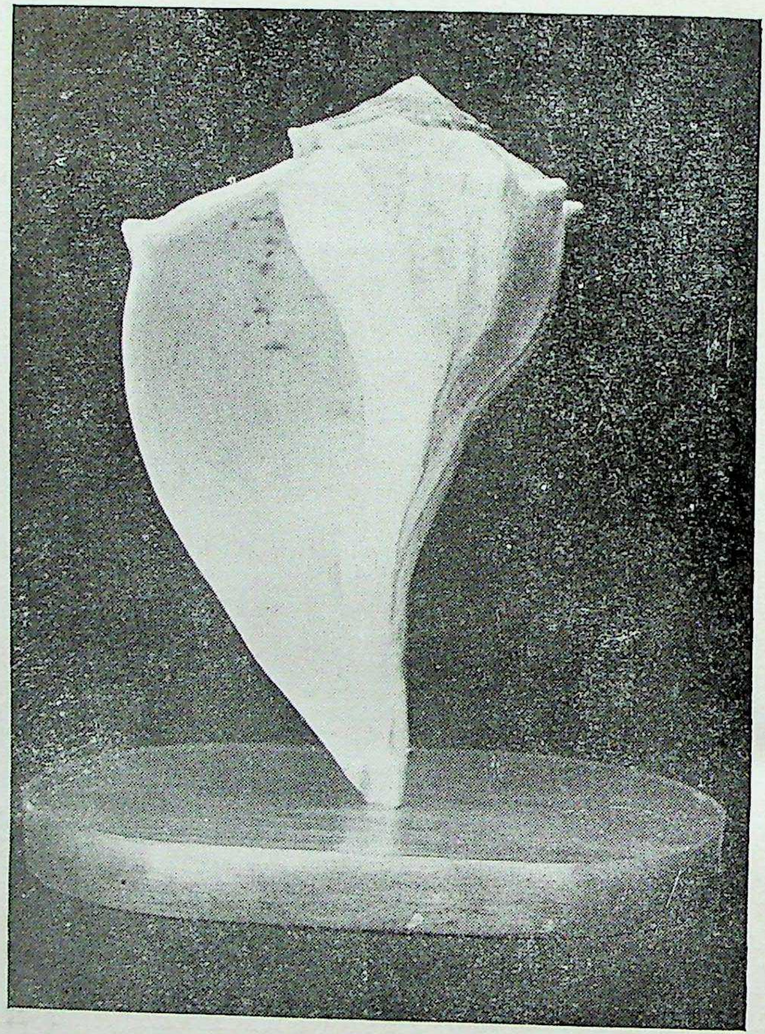

FIG. 14—PYRULA PERVERSA : A LARGE, MARINE GASTROPOD SPECIES IN WHICH THE SHELL IS NORMALLY SINISTRAL.

thick shells living on rock between tide marks in Covelong. They prey upon other molluscs by boring holes through their shells. They also secrete a purplish fluid.

The *Volutidae* (Volutes) include the great Melon shells with stongly inflated body whorl. The Melon shell (*Melo indica*), (Fig. 15) otherwise known as the " Beggar's bowl ", lives in the sea bottom about five to six fathoms deep. When crawlinge the shell is almost completely enveloped by the mantle.

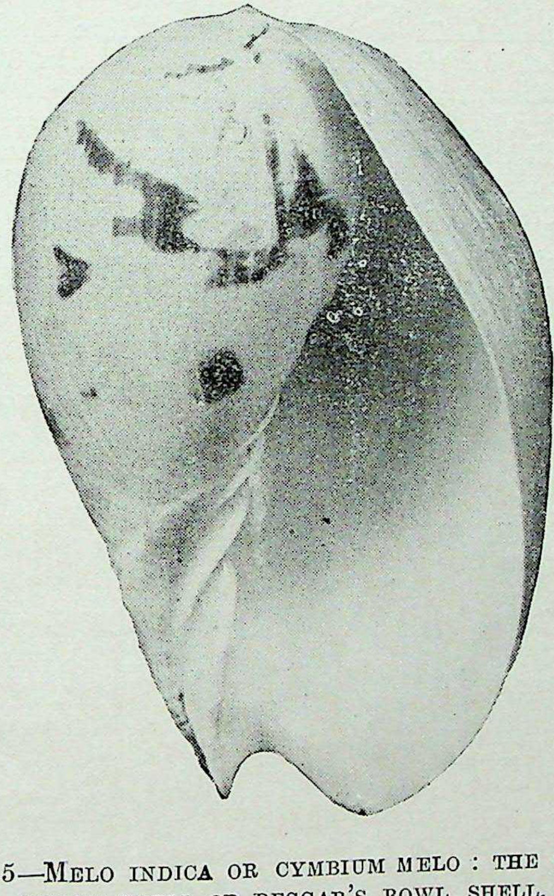

FIG. 15—MELO INDICA OR CYMBIUM MELO : THE LARGE MELON SHELL OR BEGGAR'S BOWL SHELL.

The *Olividae* include the Olives which are among the commonest species of shells found washed up on the beaches on the East coast. They are rarely seen in Malabar. These shells are noted for their high polish and the beauty of their marbled colouring. As in *Natica*, the shell is partly enveloped by the swollen foot. The Olives are very active snails, burrowing rapidly in wet sand in quest of bivalves on which they feed. The common species on the South Indian Coast are *Oliva gibbosa* and *Oliva nebulosa*. They are largely used as food.

The *Marginellidae* are small shells similar in appearance to the Olives, but the outer lip is thickened.

The *Harpidae* include the beautifully coloured Harp shells the polished surface of which is decorated with prominent, well raised transpiral ribs, suggesting the strings of a harp, hence the popular name, Harp shells. They are found in coral reef pools in the Gulf of Manaar and in the Laccadives. When irritated, *Harpa conoidalis*, our common local species, commits self mutilation by severing and throwing off the hinder part of its foot.

The Spindle shells (*Fasciolaridae*), the Mitre shells (*Mitridae* noted for their brightly coloured shells, the Whelks (*Buccinidae*), including the stout, whelk-like shells, solid, smooth and white, spotted with red squarish patches, the Nassas (*Nassidae*), which include small and often tiny shells common in shallow water in sandy areas are other common families of Gastropods belonging to the Order Stenoglossa, represented on South Indian shores.

The family *Vasidae* (*or Turbinellidae*) is special interest to India for it includes the sacred chank, *Xancus pyrum* (Fig. 16).

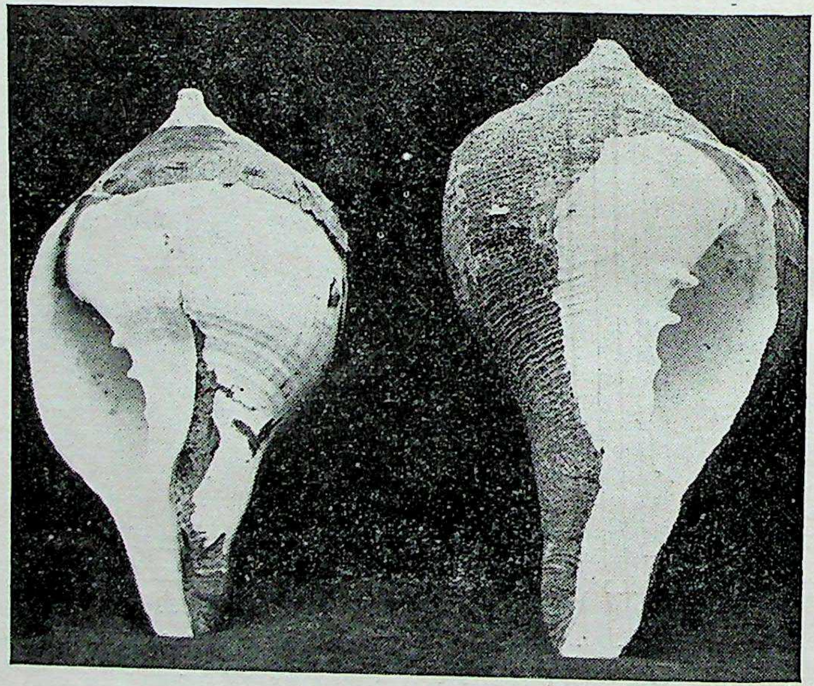

FIG. 16—XANCUS RAPA: THE SACRED CHANK: LEFT: SINISTRAL; RIGHT: DEXTRAL.

It occurs nowhere in Asia outside of India and the Andaman Islands. The Chank is gregarious and its haunts form distinct 'beds". It prefers a sandy botom where tube worms abound. These constitute its chief food. These chank beds are often most prolific in depths of from 8 to 10½ fathoms off the Tuticorin Coast. The egg capsule of the sacred chank is a familiar, horny, spirally coiled, many-chambered structure, resembling a ram's horn in appearance (Fig. 17). The lower end is anchored in the sand by means of a broad, flange-like disc. The chank is semi-burrowing in its habits. The left-handed or sinistral specimens of chanks in which the aperture is on the left hand side of the obeserver are of great value on account of the extreme rarity and are held in veneration by Hindus and Buddhists. Two sinistral specimens of the sacred chank, together with the horny spiral egg capsule of this species are exhibited in the wall case.

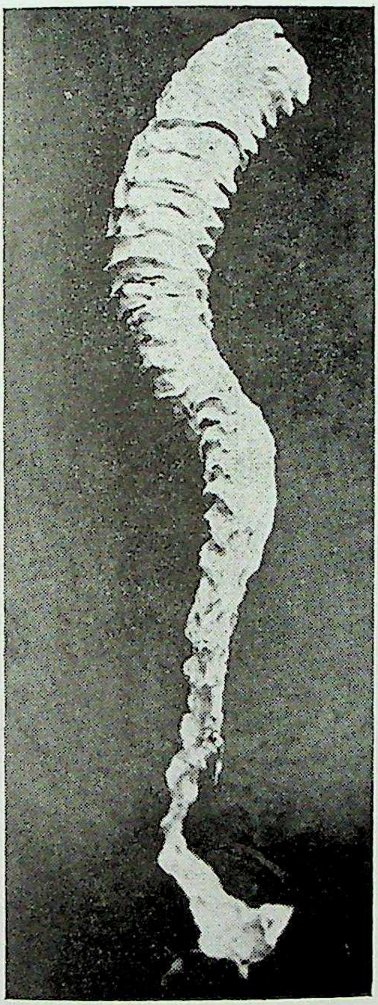

FIG. 17—HORNY EGG CAPSULE OF THE SACRED CHANK : XANCUS RAPA.

Order *Toxoglossa.*—The remaining three families, namely, the *Turridae*, *Condidae* and *Terebridae*, possess a large poison gland in the gullet; they together constitute the tribe of the "poison-toothed Mollusca", or Toxoglossa. They are carnivorous in habit.

The Cones (*Conidae*) as their name implies, are more or less conical in shape. The spire is short and the aperture narrow and linear. This family includes many species of brilliantly coloured shells with attractive colour patterns and markings. Some species are dangerous to handle on account of the poisonous nature of their bite. Several common species inhabit our coral reefs and lagoons. *Conus textile*, *Conus amadis*, (Fig. 18), *Conus hebraeus*, *Conus figulinus*, etc., are some of the common South Indian species. The *Conidae* are mainly found in tropical seas.

The *Turridae*, including the Slit-lips, are even more numerous in species than the Cones. They are world-wide in distribution with a fusiform shell, a tapering spire and an elongated body whorl. A deep slit or notch in the thin outer lip of the shell is their characteristic feature.

The *Terebridae* includes the Auger shells; these are very greatly elongated, tapered shells consisting of many whorls resembling the Turret shells or Turritelidae, but usually with a smooth surface, and brightly ornamented with coloured spots. They include some of the most beautiful of gastropod shells. *Terebra duplicata* is a common South Indian species often found in moderate depths on sandy bottom *Terebra subulata* is a fine shell attaining a length of more than six inches.

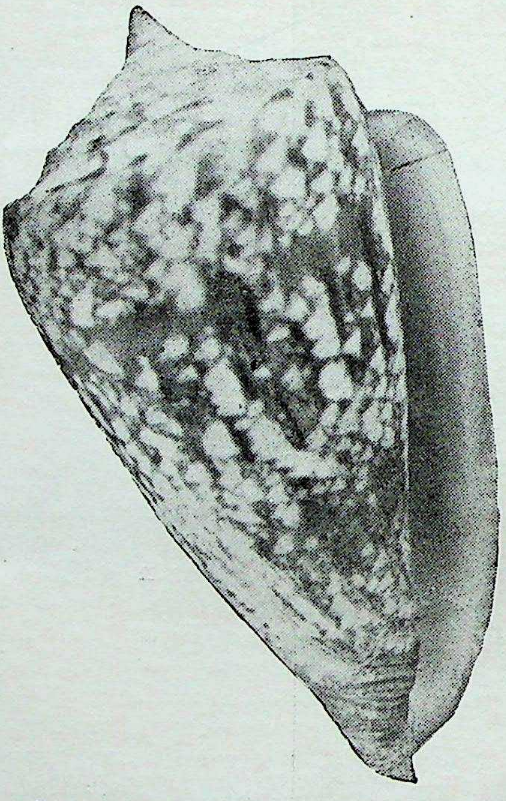

FIG. 18—CONUS AMADIS: A TYPICAL CONE SHELL.

Subclass OPISTHOBRANCHIA.

This subclass includes forms in which the shell shows a marked tendency to be reduced, rudimentary, or absent altogether. It includes the Bubble shells (*Bullidae*), the Sea hares, (*Aplysiidae*), the large and interesting shell-less group, the Nudibranchs, which have their feathery gills fully exposed and arranged in a circle, and other less familiar forms.

The *Bullidae*, or Bubble shells, are abundant on sandy bottom in shallow water. The swollen oval shells of *Bulla ampulla* are often washed ashore on the Madras and Pamban beaches. An extremely beautiful species is the Striped Bubble shell, *Hydatina velum*, with a thin, fragile shell, beautifully ornamented with broad, black, widely spaced spiral bands.

In the *Philinidae*, the shell is very thin and small and almost embedded entirely inside the animal. The form of the body is fully adapted for burrowing. The lobes of the body are fleshy and smooth, without any projections, the whole looking like an animated plough-share, perfect for its purpose of burrowing rapidly.

The Sea hares (*Aplysiidae*) are heavily built, fleshy creatures, soft-bodied, with a thin, much reduced transparent ear-shaped brown shell embedded in the mantle. They are common in weedy shallows in bays and the seaward ends of backwaters. They vary greatly in abundance from year to year, being seasonal in occurrence. Sometimes they appear along the shores in multitudes; at other times they are scarce. When handled, these animals discharge a large quantity of purple fluid from under the mantle, the function of the fluid being protective. The egg masses of *Aplysia* are in the form of long, tangled cords. Specimens of Sea hares are exhibited in the wall case.

The *Pleurobranchidae* include dull-coloured, slug-like animals. *Pleurobranchus* is greenish drab in colour, with a rough surface. The head bears two pairs of fleshy tentacles.

Pteropods.—These are often known as the Sea butterflies on account of their peculiar shape, with wing-like lateral expansions of the body. They spend their whole life in the open sea, often occurring in vast swarms. The foot is modified into a pair of great wing-like fins. Pteropods form the principal food of the Baleen Whale. The shells of the Sea butterfly, *Cavolinia longirostris*, which are thin, white and fragile, have often been collected on the Madras Beach.

Nudibranchia.—This is an important group of naked-gilled molluscs including several families, which are well represented among rocks overgrown with weeds along the sea shore. They include many beautiful and brightly coloured forms. They are slug-like animals, without a shell of any sort, and bearing brightly coloured, feather-like branched processes on the back, serving as gills.

The rough, yellowish Sea lemon, *Doris*, lives largely on sponges, while the small Nudibranch, *Bornella digitata*, with club-shaped processes on the back, feeds mainly on zoophytes.

On the Madras Coast, several creeping forms occur, notably the large, ornate *Kalinga ornata* and species of *Arminia*, but the only Nudibranch that seems to be at all frequently thrown up on the beach is the curious little blue, pelagic *Glaucus marina*. When in good condition in the sea, it floats on its back which is whitish, the ventral surface which is thus in practice the upper surface, being of a beautiful deep blue colour.

Kalinga ornata is a large, beautiful Nudibranch, with its sparsely tuberculated upper surface adorned with a circle of well developed feathery gills behind, and more or less fringed with much smaller processes of a similar kind. It is beautifully ornamented with bright red spots and blotches. A species of *Discodoris*, found among mussels, etc., in the Madras Harbour is much smaller.

Subclass PULMONATA.

The Pulmonata are air-breathing forms in which the walls of the mantle cavity are modified to constitute a lung, but a few freshwater forms have re-acquired gill-like breathing organs. This group includes our familiar land snails and slugs. A few forms such as the Ellobiidae (*Melampus*, etc.), and the Siphonariidae (lung limpets) have secondarily reverted to a marine habitat. *Onchidium*—a rather robust, fleshy sea slug with a tough, leathery integument and a shell-less body is common on the sea shore in sandy areas, particularly in localities around Porto Novo and Kundugal Point at Pamban.

There are several common species of garden snails, the shells of some of which are exhibited. Formerly all these were included in the genus *Ariophanta*, but now the generic name *Ariophanta* is reserved only for species having sinistral shells and hence our ordinary garden snails with dextral shells have been assigned to various genera such as *Cryptozona* and *Hemiplecta*. *Hemiplecta basileus* is the large Imperial snail with a magnificent shell growing to about 2½ inches in diameter, common in the Cochin teak forests, and occasionally eaten by the natives. Two smaller species are abundant in Madras gardens; one is the single-banded *Cryptozona ligulata* and the other the two-banded *Cryptazona* (*Xestina*) *bistrialis*. *Achatina fulica* is a large land snail originally found in Africa, but it has been subsequently introduced into Ceylon, Andamans and parts of India where it has multiplied rapidly and has become a pest, causing great damage to vegetable gardens.

Of the freshwater snails belonging to the Pulmonate group. *Limnaea* and *Planorbis* are the best known genera. *Limnaea* has a thin, elongated, elegantly spirally coiled shell with a long inflated body whorl and wide aperture, while in *Planorbis* the shell is discoidal, and coiled in a flat, sinistral manner. In *Limnaea*, the shell is thin and fragile, while it is much stouter in *Planorbis*. Both *Limnaea* and *Planorbis* have the habit of crawling upside down beneath the surface of the water, the foot gliding along exactly as if it were moving along a sheet of glass. This is made possible by surface tension of the water. They frequent all our tanks, ponds and streams, especially those with weedy vegetation. In hot weather, when tanks and streams dry up, they aestivate in the mud in the same way as the Apple snail, *Pila*, or the Banded pond snail, *Vivipara*.

Class III—SCAPHOPODA.

The Scaphopoda are marine, bilaterally symmetrical Mollusca, with the body and shell elongated and more or less cylindrical. Their narrow, tubular shells are known as " tusk shells " by reason of their striking resemblance in shape to the tusk of an elephant, the concave side being the dorsal and the convex side the ventral. The shell is open at both ends, the anterior end being broader than the posterior. In the living condition, the foot and the cephalic tentacles known as *captacula* can be projected through the front aperture. The foot is muscular, cylindrical and adapted for burrowing in the soft sand. The animals live half buried in sand at the sea bottom, with the narrow posterior extremities of the shell projecting into the water. Tusk shells of the genus *Dentalium* are often very common in sandy ground at the sea bottom in depths of a few fathoms around our coasts. Their empty shells are often cast up ashore and resemble tiny, miniature elephant tusks in shape. The most abundant species in South India is *Dentalium octangulatum* with eight longitudinal ribs on the shell. These animals live buried obliquely in the sand with the pointed end of the shell pointing upwards. The water required for breathing passes through the small perforation at this end. The food of the tusk shells consists of Foraminifera and minute bivalves. Tusk shells are often found abundantly in dredge collections.

Class IV—PELECYPODA. (= LAMELLIBRANCHIATA).

This Class constitutes another large and important group of shell-bearing Molluscs, comprising a wide variety of forms such as the scallops, mussels, oysters, clams, cockles, wedge shells, feather shells, paper shells and their allies. In this Class, the shell is bivalve, that is to say, it is made up of two valves—right and left, which are firmly hinged together at their apex, known as the umbo. The hinge bears a set of interlocking teeth—the hinge teeth—supplemented by a horny ligament. The mantle is also made up of two lobes, right and left, and encloses the mantle cavity in which the lamelliform gills are placed. The foot is generally laterally compressed, and more or less wedge-shaped, and in many lamellibranchs it enables the animal to burrow rapidly in sand or mud (Fig. 19).

The majority of bivalves pass their lives in burrows in sand or mud; others anchor themselves by a cable of fine threads, the *byssus*. In some species (e.g., the oysters), one valve is firmly cemented to rocks; a few bore into wood and stone and others are active and swim by flapping their valves. Their food consists of minute organisms, animal and vegeable, swept within the cavity enclosed by the mantle lobes by rhythmic ciliary movements.

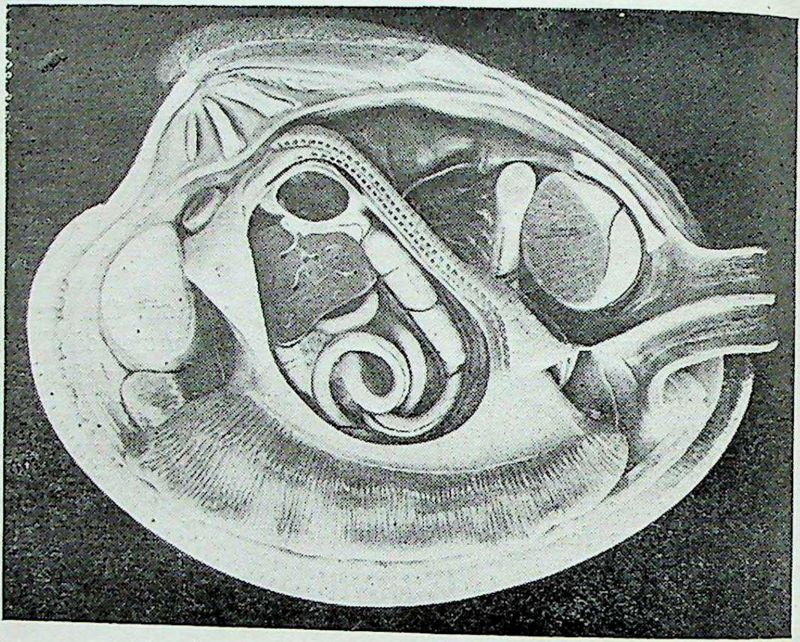

FIG. 19—ANATOMICAL MODEL OF A CLAM SHELL (PHOTOGRAPH ONLY EXHIBITED).

According to the latest scheme of classification adopted by Thiele, the Class Pelecypoda is broadly divided into three orders, the chief characters of which are briefly outlined below :—

1. *Order Taxodonta.*—The hinge margin bears more or less numerous, undifferentiated and uniformly developed teeth. Two adductor muscles are always present.

2. *Order Anisomyaria.*—The anterior adductor muscle is reduced or more or less completely suppressed. Real hinge teeth are scarcely present, but sometimes small tubercles or distinct tooth-shaped processes are developed. The embryonic shell bears a striated hinge margin. The mantle is open, without siphons. The gill lamellae are either smooth, with evenly developed filaments, or plaited with unequal filaments.

3. *Order Eulamellibranchiata.*—The mantle often bears posterior siphons. The anterior adductor muscle is seldom reduced or suppressed. The hinge teeth are usually few in number, and those

of the two valves closely interlock with each other. A right central tooth and lateral tooth are often present. The gill filaments, as a rule, form two plaited lamellae which are always connected together by vascular junctions.

Each of these Orders includes a number of families many of which are well represented on Indian shores. The chief characteristics and habits of the members of some of the more important of these families, which are represented by exhibited specimens in this gallery, are briefly decribed below, arranged under their respective Orders.

Order TAXODONTA.

The *Arcidae* include the shells popularly known as the Noah's Ark shells. This is a large family of bivalve shells varying widely in appearance and habit. The hinge is straight, with a number of perpendicular teeth (pliodont). The best known Indian species are *Arca granosa*, *Arca fusca*, *Arca indica*, *Araca lateralis*, *Arca inaequivalvis*, *Arca complanata* and *Arca tortuosa*. Several species have been recorded from Madras and Krusadai. Some live attached to pieces of dead coral and shingle or reefs. *Arca complanata*—a form covered by a hairy periostracum—is common on the large blocks of stone beneath the Pamban Bridge.

Order ANISOMYARIA.

The *Mytilidae* is the well known family of Mussels. All of them have elongated shells with the hinge close to the anterior end and without hinge teeth. In Mytilus, the umbones are right at the end. The common Horse Mussel or Green Mussel, *Mytilus viridis* lives attached to rocks by means of a byssus (a bunch of horny fibres). Pearls are also produced by this Mussel. A large shell of this Mussel with a few specimens of pearls secreted by it are exhibited in the wall case. The Data shells, *Lithophaga spp.*) are long, cylindrical mussels which tunnel into limestone rocks and corals and sometimes into massive gastropod shells. They bore only into shells, corals and calcareous rocks.

A large and varied family, *Pteriidae* includes the well known Pearls Oysters. *Pteria vulgaris* (Fig. 20) and *Pteria margaritifera* are two of the most common species of Pearl Oysters recorded from Indian waters. They are gregarious and form regular beds around Tuticorin, Ceylon and the Gulf of Manaar. They live attached to rocks and stones by a strong byssus. They are capable of crawling short distances.

Another section of this family includes the Wing Mussels (*Pteria chinesis*, etc.), in which the shell is comparatively thin and smooth and the hinge margin bears greatly elongated wing-like expansions—the *auricles*. Some of these occur in clusters attached to Gorgoniids (e.g., *Avicula radiata*).

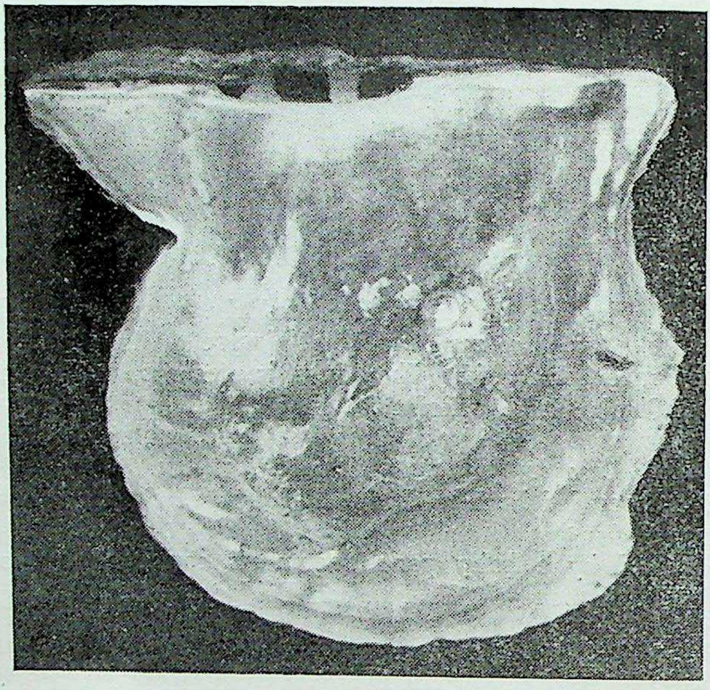

FIG. 20—INTERIOR VIEW OF SHELL OF PEARL OYSTER, PINCTADA VULGARIS, SHOWING FORMATION OF PEARL.

The *Isognomonidae* (= Vulsellidae) includes the peculiar Hammer Oysters and their allies. The shell is laterally compressed and more or less flattened, with a straight, toothless hinge. The ligament bears one or more horny nodules. The Hammer Oyster, *Malleus malleus*, is a blackish, irregular, corrugated shell, shaped more or less like the letter 'T', the cross bars at the top representing the two enormously developed 'ears' or auricles and the upright bar, the high, narrow, main body of the shell.

The *Pinnidae* includes the large, elongately triangular shells commonly known as the 'feather shells'. The most common species found in the Gulf of Manaar are *Pinna atropurpurea* and *Pinna bicolor*—a big, wedge-shaped shell growing often a foot in length. It occurs commonly on the sand bottom on the east coast, living in depths from just below tide mark to about six fathoms. It lies buried to half its length or more, point downwards in the sand, the posterior broad edges gaping. It has a tongue-shaped foot and a strong byssus for attachment.

The *Pectinidae* includes the Scallops and their allies. The true scallops are included in the genus *Pecten*. These shells have two well developed processes of the hinge margin, the " ears " or the " auricles ". In the young condition they attach themselves to stones and rocks by means of a byssus, but when they grow into adult shells they usually become free swimming and are very active in their habits. They swim rapidly by alternately closing and opening their valves. The edge of the mantle bears well developed eys. The thorny oysters (Spondylidae) in which the shell is beset with spines, are also included in this family, but these are sedentary, in which the right valve becomes cemented to rocks and boulders. The smooth, circular, flattened fleshy pink shells popularly known as the " sun and moon shells " (*Amussium pleuronectes*) also belong to this family.

The *Anomiidae* include the Window pane Oysters (*Placenta placenta*). The shell is large, strongly laterally compressed and often thin and translucent. The young sheli is attached by a byssus, but the adult is unattached, without any trace of the

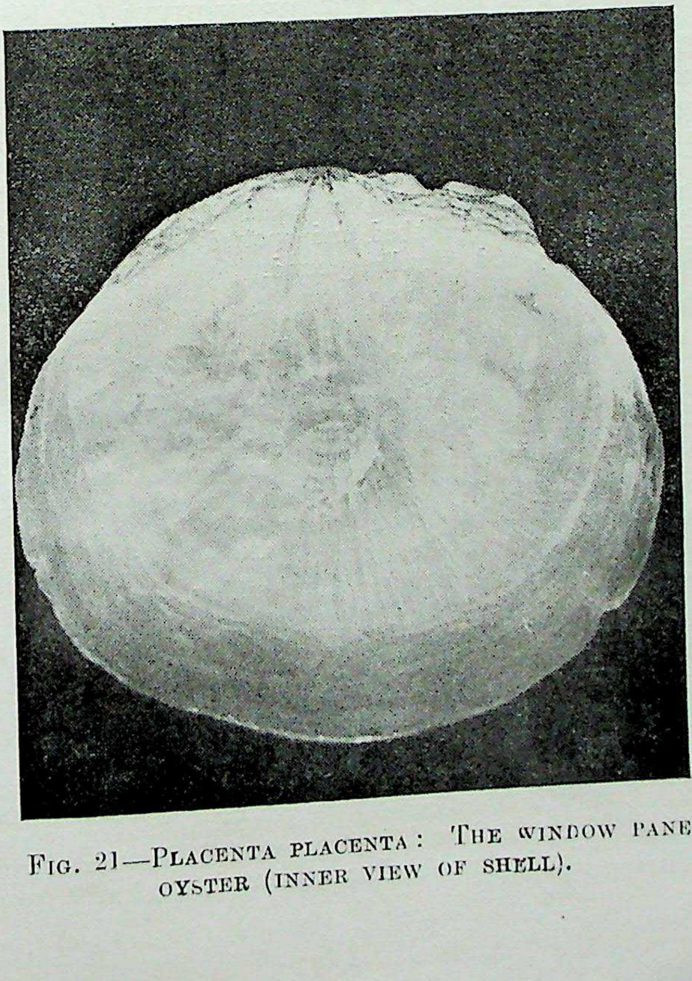

FIG. 21—PLACENTA PLACENTA : THE WINDOW PANE OYSTER (INNER VIEW OF SHELL).

byssus or byssus cleft. *Placenta placenta* is the common Window pane Oyster of the Indian shores (Fig. 21). In China these shells are used for making window panes.

The *Ostraeidae* include the true Oysters in which the shell is inequivalve, more or less irregular and the left valve firmly attached to some substratum. The hinge margin is toothless. The margin of the shell is often thrown into folds. The foot and byssus are rudimentary. All of them live a sedentary life after the early free-swimming stage is past. The commonest South Indian species are *Ostraea forskalii*, the rock oyster, *Ostraea virginiana* or *Ostraea madrasensis*, the backwater oyster in which the valves are more elongated and less strongly folded at the edges, and *Ostraea crista-galli*, the Cock's comb oyster in which the margin of the shell is thrown into strong, deep and sharply angular folds resembling a Cock's comb. Oysters have shells which are extremely variable in form, and often conforming in shape to the surroundings.

Order EULAMELLIBRANCHITA.

This Order includes by far the vast majority of shells known as clams and cockles and comprise all the remaining families of bivalves recorded from Indian shores. Selected specimens of shells belonging to most of these families are exhibited.

The *Carditidae* include the so-called "false cockles", e.g., *Cardita bicolor*, radially ribbed and spotted with reddish brown, common on sandy and gravelly ground.

The *Lucinidae* comprise the "bladder shells" in which the shell valves are rounded and inflated like bladders.

The *Erycinidae* (formerly known as *Galeommidae*) include tiny bivalves remarkable for the way the mantle folds are reflected outward over the edges of the valves, nearly concealing them. The foot is long and flattened on the under side. *Galaeomma paucistriata* and *Scintilla hanleyi* are two species with thin and fragile whitish, translucent shells, commonly met with at Krusadai; they possess remarkable powers of swimming.

The true cockles are included in the family *Cardiidae*. The shell is rounded and almost invariably (and usually strongly) radially ribbed. Most of the common ribbed bivalve shells thrown up on the beach belong to this family.

The large and varied family *Veneridae* includes the shells popularly known as the clams. It comprises numerous genera, as many as fifteen of them being represented in the Krusadai Island area. The backwater clams (*Meretrix spp.*) with powerful muscular foot with which they burrow in soft sand and mud, are familiar examples of this family. Many of the clams are strongly ribbed or tuberculated and some are prettily ornamented with colour markings.

The *Donacidae include* the "Wedge shells". In these shells the umbo is placed more posteriorly and most of them possess a sharp or blunt keel running down obliquely from the umbo. The common Madras forms are *Donax scortum* and *Donax cuneatus*. The latter species is abundant between tide marks and for some short distance below low water level. These shells burrow rapidly in the soft sand and live buried an inch or two below the surface layer of the sand. The larger and more handsome *Donax scortum*, with its purple, concentrically sculptured valves, is less common, but its empty valves are frequently washed ashore on the beach.

The *Mactridae* includes the so-called "false clams", usually with smooth, highly polished and inflated shell valves. They are distinguished from the true clams by the hinge ligament being provided with a large internal nodule behind the cardinal teeth and the presence of a prominent hollow in the hinge to accommodate this nodule.

The *Psammobiidae* include species with elongated shell valves common in brackish water and estuarine areas. A well known example is the large, deep bluish, elongate shell, *Sanguinolaria (Soletellina) diphos* common in sandy areas in the vicinity of brackish water.

The *Tellinidae* include the "paper shells". Most of them are rather thin, fragile shells. Numerous species are represented along the Madras Coast. The shell is more or less oval, sometimes elongate, or pointed behind. The pallial sinus is large and its lower margin is often fused with the lower part of the pallial line. Many of these shells are found in great abundance in sand or mud at the bottom of backwaters.

The *Solenidae* include the remarkable "razor shells" in which the shell valves are elongated, straight and parallel-sided, and the "sunset shells" in which the thin, purplish oblong shell valves are prettily marked with radiating white bands like the rays of the setting sun. Razor shells have enormously well developed foot, cylindrical in form and capable of burrowing easily into loose sand. At low tide, the slot-ike openings of their burrows are often exposed.

The most common species of freshwater bivalves belong to the families *Unionidae*, comprising the freshwater mussels in which the interior of the shell is pearly, and *Corbiculidae* which include the freshwater clams in which the shell is not pearly within, and the shape of the shell is more triangularly ovate.

Lamellidens marginalis belonging to the family *Unionidae* is the common Indian freshwater mussel, generally dissected in our laboratories. Living specimens of this species are found abundantly in all freshwater ponds and rivers. These animals are ovo-viviparous and are very prolific breeders.

The Giant Clams, belonging to the family *Tridacnidae* are the largest and heaviest of all molluscan shells. They are popularly known as the "Holy water Clams" on account of the use to which they are put in Roman Catholic churches in Europe. The shell reaches a length of four feet and attains a weight of over 500 pounds in exceptional cases. They live mostly associated with corals on reefs, and are most numerous and attain their greatest size on the Great Barrier Reef and the South seas. They are remarkable for the powerful muscular grip of their massive valves and have been known to trap the limbs of many an unwary diver who is doomed to a watery grave once he is caught in its fatal clutches. A pair of the large and heavy shell valves of the Giant Clam (*Tridacna cumingii*) from the Laccadives (Figs. 22 and 23), are exhibited in this gallery.

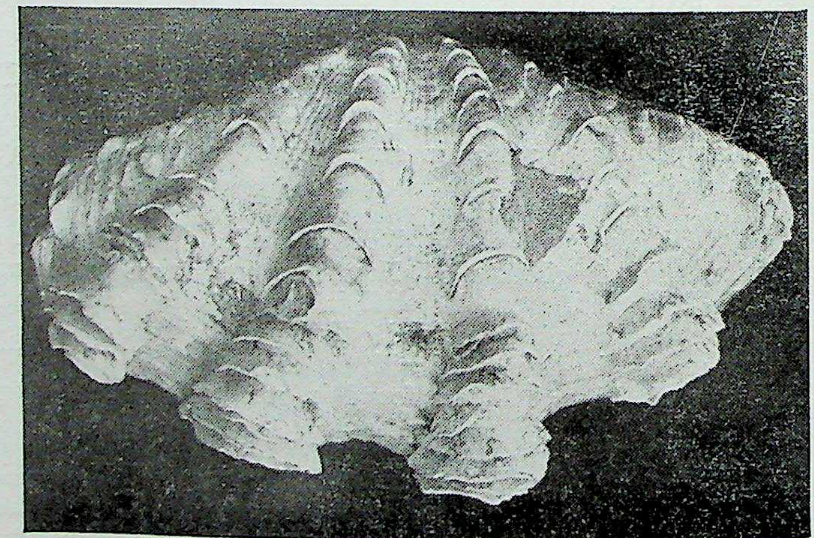

FIG. 22—TRIDACNA CUMINGII: THE GIANT CLAM (OUTER VIEW OF SHELL).

The Borers or Piddocks, belonging to the family *Pholadidae* bore into wood and stone. The shell is variable in size and shape, and one or more accessory calcareous plates are sometimes formed. In India, borers are seldom found in rock; instead, they are found in peaty and clayey deposits or in wood. *Pholas orientalis*, a large, fine, white sculptured shell, long and tapering behind, is a common Indian species found borrowing in the stiff clayey deposits on the North coast of Palk Straits to the west of Point Calimere. In floating timber, other borers of this family are found—a common Indian species being *Martesia striata*, a small whitish shell boring into pieces of floating wood.

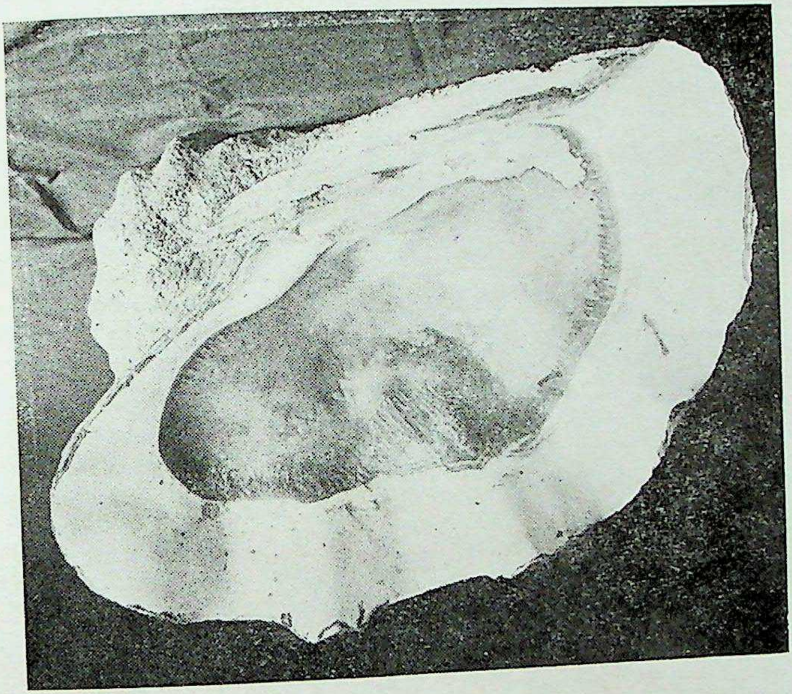

FIG. 23—TRIDACNA CUMINGII : THE GIANT CLAM (INNER VIEW OF SHELL).

The Ship Worms (*Teredo* spp.) (Fig. 24) are still more highly specialized for boring, but they confine their attention entirely to wood. The body is long and worm-like, and their burrow is lined by a calcareous tube. They are gregarious and are extremely destructive to timber, especially to ship's timber in the tropics. The hardest wood is not immune to their attack.

Finally, mention may be made of the peculiar Watering Pot or Pepper Pot shells of the family *Clavegellidae*. A common Indian species is *Brechites dichotomus*. Specimens of this species are common on our shores, washed up after storms. They are degenerate forms, and may sometimes be seen embedded upright in the sand at very low tides. Their shells are greatly reduced and minute in size, and attached in a gaping position to a large calcareous tube, the anterior end of which is perforated by a number of pores, each pore being surrounded by a slight elevation of its margins. The periphery of this end bears closely arranged tubuli. The other extremity of the tube is open.

Class V—CEPHALOPODA.

The Cephalopods are so called because the foot, here divided into a number of tentacle-like arms, is attached apparently to the head. They include the cuttlefishes, squids and octopuses.

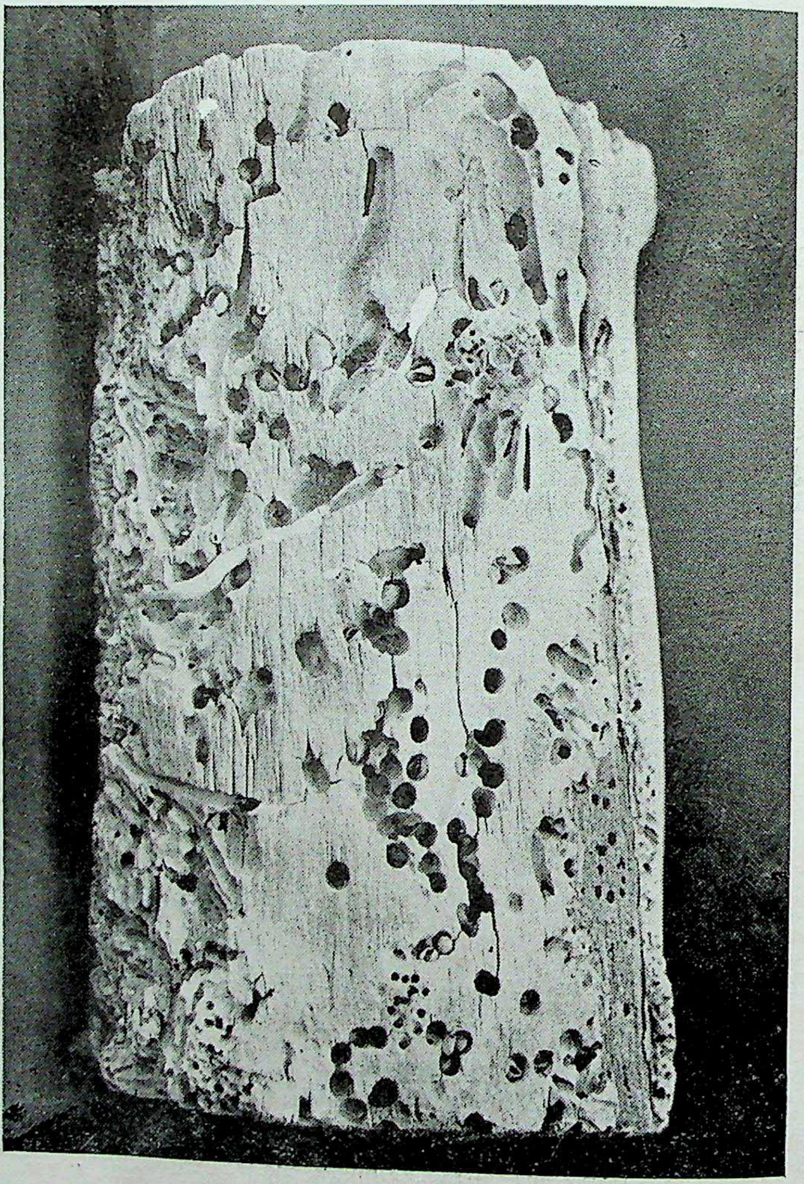

FIG. 24—PIECE OF WOOD ATTACKED BY THE SHIP WORM, TEREDO (UPEROTUS) CLAVA, A WOOD-BORING MOLLUSC.

The Cephalopoda are divided into two main groups, namely, (1) the Tetrabranchiata, characterized by two pairs of gills and a lobed foot bearing tentacles and including the genus *Nautilus* and (2) the Dibranchiata, with only a single pair of gills and the foot modified into ten or eight arms bearing suckers, and including the remaining genera of the Cephalopoda. All of the main types of Cephalopods are represented on the Madras Coast and on the East Coast of South India generally, and selected specimens of the most important species are exhibited in this gallery both in the form of dry-preserved shells and wet-preserved specimens.

Subclass TETRABRANCHIATA.

The Pearly Nautilus is the only existing form belonging to this group, but this group was much better represented in the earlier Geological ages (*Ammonites*, *Belemnites*, etc.). *Nautilus* possesses four gills, and a beautiful, large, spirally coiled shell,

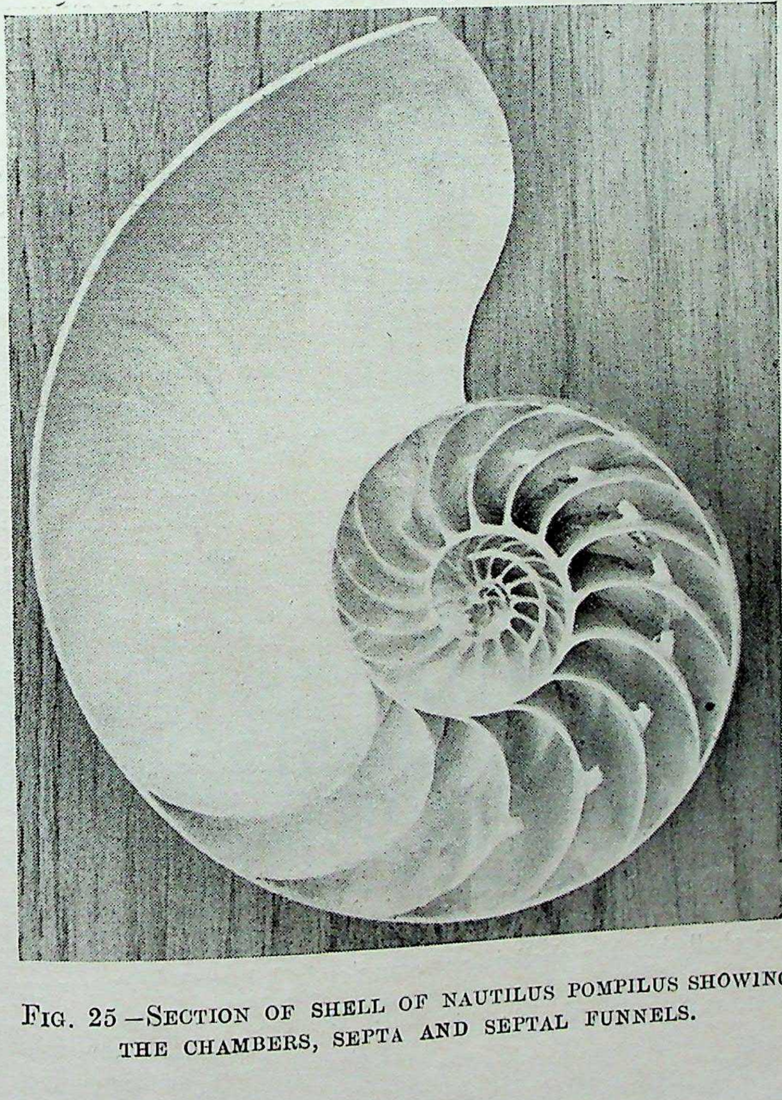

FIG. 25.—SECTION OF SHELL OF NAUTILUS POMPILUS SHOWING THE CHAMBERS, SEPTA AND SEPTAL FUNNELS.

prettily ornamented externally with wavy colour markings and with an exquisite pearly lustre within. The shell is divided into numerous chambers by means of a series of septa or walls which are pierced by a hole in the centre through which a process passes in the living state of the animal. Specimens of an entire shell of *Nautilus pompilus* and a section of the shell (Fig. 25) to show the chambers and the septa, are exhibited.

Subclass DIBRANCHIATA.

This group is further divided into two Orders: (1) the Octopoda, including the common Octopus and the Paper Nautilus, *Argonauta*, in which there are only eight arms, and (2) the Decapoda, including the cuttlefishes, squids and the curious little Ram's horn shells, *Spirula*, with ten arms.

The Octopoda, Comprising the octopuses (Fig. 26) have neither internal nor external shells. Some attain a very large size. These are active creatures swimming freely in the sea and are by far the most intelligent among the Mollusca. They abound in weedy shallows of the littoral zone. They are as a rule solitary and frequent rough bottom.

The Decapoda include the cuttlefishes and squids. Cuttlefishes are less intelligent and are more gregarious in their habits, swimming swifty through the water often in immense numbers. Several species of cuttlefish are known from Madras and Pamban Coasts. Their brittle, calcareous, internal skeleton known as the cuttlebone, is often washed up on the beach. The squids (*Loligo*) are more active, their bodies being long and torpedo-shaped and armed with a powerful, triangular fin on each side of the body. The internal skeletal structure of the squids is in the form of a thin, horny blade—the *gladius*—which rarely ever survives being washed up on the beach. Squids and octopuses can propel themselves swiftly backwards by the principle of jet propulsion. They all have an ink sac for defence. A shoal of these elegantly streamlined squids swimming through the water is a captivating sight. In some parts of India the flesh of cuttlefish and squids is eaten by poor people.

The Ram's horn shell, *Spirula*, is included in the Decapoda along with cuttlefishes and squids. It has a chambered, spirally coiled shell, but the shell is not completely internal. The species common at Madras has been identified as *Spirula prototypos* (now known, as *Spirula spirula*); this species is also common at Krusadai. The empty shells of *Spirula* are sometimes abundant on the beaches, but very few shells with the animal *in situ* have been collected.

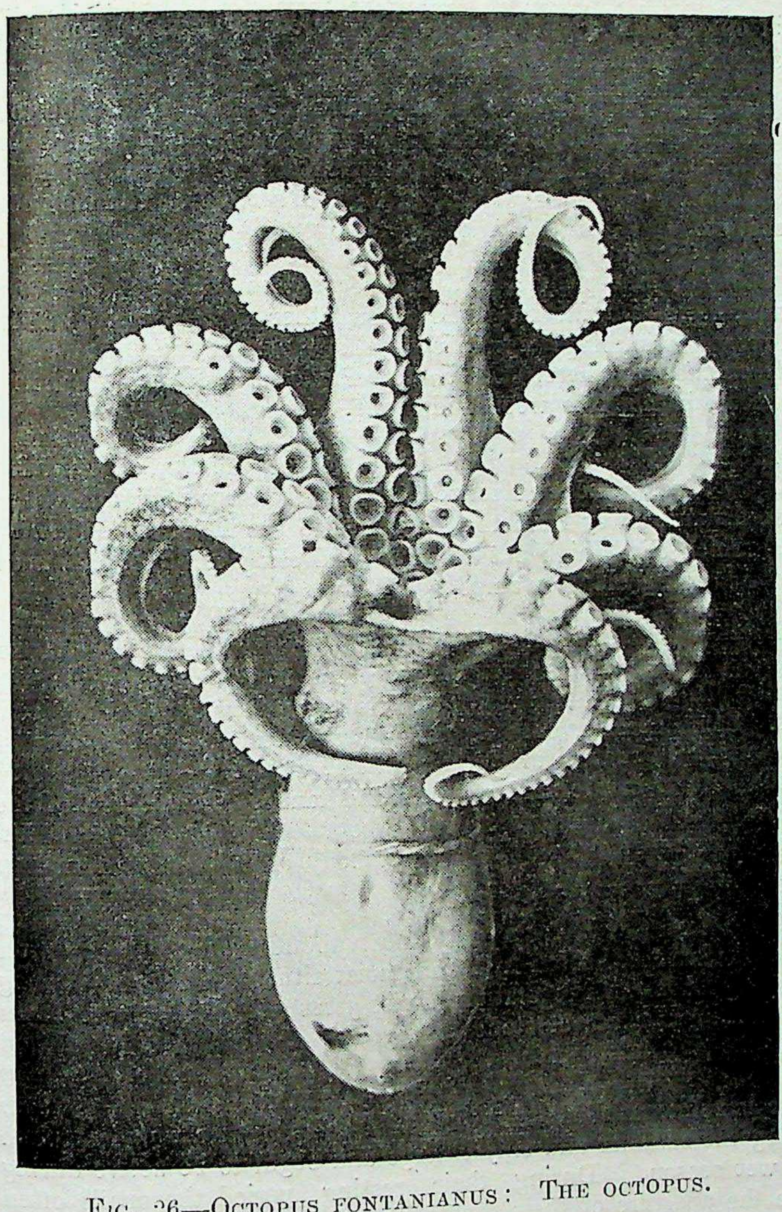

FIG. 26—OCTOPUS FONTANIANUS: THE OCTOPUS.

ECOLOGY OF SOUTH INDIAN MOLLUSCS.

Ecologically, Molluscs may be classified as marine, brackish water, freshwater and terrestrial and again, in each of these groups there are different types of habitats in which the living molluscs may be found.

Among marine forms, for instance, some species may live attached to rocks (e.g., *Chiton, Haliotis, Patella* including the Limpets, etc.) by means of their flatened muscular foot. Others may be found attached by means of their byssus, e.g., *Mytilus*. Still others, like oysters, may be cemented to rocks by means of their left valves.

Another group of marine molluscs live in sandy shores, burrowing in the soft mud, e.g., *Natica, Oliva*, Clams, *Donax*, etc. Others live at the sea bottom particularly buried in the sand and may be obtained by means of dredging, e.g., *Dentalium*, chanks, cone shells, etc.

Some may be pelagic, floating on the sea surface by wave action, e.g., *Janthinidae*, while a few other species possess active powers of swimming, e.g., the scallops (*Pectinidae*) and the *Galaeommide*. Others, such as the Piddocks (*Pholas*) are boring molluscs, boring into wood and stone.

Brackish water forms include species of *Cerithium, Neritina, Meretrix*, etc., which are found gregariously on weedy mud flats some distance away from the sea and also the Periwinkles (*Littorina*) which climb high out of water and cling to stems of mangroves growing along swamps.

Freshwater molluscs are found almost everywhere in tanks, pools, paddy fields and lakes and are especially abundant in water having plenty of water weeds which are rich in calcareous content. Some species, such as fresh water mussels, are found on sandy bottom in clear running water, while others lie buried at the bottom in the mud of pools and tanks. The larva of the freshwater mussel, known as the *Glochidium* larva, leads a parasitic existence, living attached to the body of some host by means of its byssal filament.

Land molluscs are generally most abundant during and after the rains, and are often found in moist situations such as among decaying leaves and vegetation, moist grass and moss, under barks of trees, in crevices of stones and rocks, under logs of wood and in groves, gardens, orchards, parks, sometimes sticking to and climbing on to the stems of plants, and found generally wherever there is sufficient moisture. Most of them aestivate underground during the summer and only emerge and begin to be active during the wet season. During their resting period the snails often close the aperture of their shell with a film of dried mucus to retain their own moisture. This film is known as the "epiphragm" or "hybernaculum" and has usually a small aperture left near the centre as an air passage. The operculate land snails, however, have only to close the mouth of their shell with the operculum. Land molluscs are particularly abundant on the hills, many species in South India having been recorded from the slopes of the Nilgiris, Pulneys, Shevroy and Anamalai Hills. Some snails are habitually found in the forests, the large Imperial snail, *Hemiplecta basileus*, found in the Cochin teak forests being a classical example.

ECONOMIC AND ORNAMENTAL USES OF MOLLUSCS.

Shellfish have been put to an enormous variety of uses from the earliest times. Oysters, mussels, clams, cockles and many species of land snails have been consumed as human food in various parts of the world. Oysters are regularly cultivated in oyster farms which are abundant to-day in France, England and the United States of America. The English edible oyster is *Ostraea edulis*, the flesh of which is considered as a delicacy. The soft parts of the Ear shell, *Haliotis*, or Abalone as it is sometimes popularly known, is also esteemed as a favourite article of food in certain parts of the world. In South India, however, probably the most favourite edible mollusc is the common backwater clam, *Meretrix ovum*, its flesh has a fine flavour, and is tender and nutritious.

Shells have also been extensively employed by man as ornaments right from the period of the Stone Age. A few selected specimens, illustrating the ornamental uses of sea shells including a fine specimen of cameo-carving on a shell of *Cassis madagascariensis* (Fig. 27) are exhibited in a separate wall case at the end of the Molluscan Section in this gallery.

The present day primitive tribes in all parts of the world use shells in various ways for personal adornment, often by simply boring them and stringing them into bracelets and necklaces. In the Rameswaram shell bazaar, large numbers of the little, prettily ornamental spindle shell, *Pyrene versicolor*, may be seen strung together to form attractive necklaces. Sections of such shells as the Top shells (*Trochus*), Cone shells (*Conus*) and Chank shells (*Xancus*) have often been polished and used as rings, bangles and armlets.

At the present day, the range and variety of the ornamental uses of molluscan shells are practically endless. The Helmet shells (*Classis spp.*) are largely used for cameo-carving which is a flourishing skilled industry in Italy. Several large and attractive shells such as those of *Nautilus* and the Giant Clam have come in handy for use as lamp shades and ornamental pieces in gardens and aquaria. Pearl oysters which yield the precious natural pearls of commerce have formed the basis of a valuable industry in Ceylon, Tuticorin and other parts in the East from very remote times.

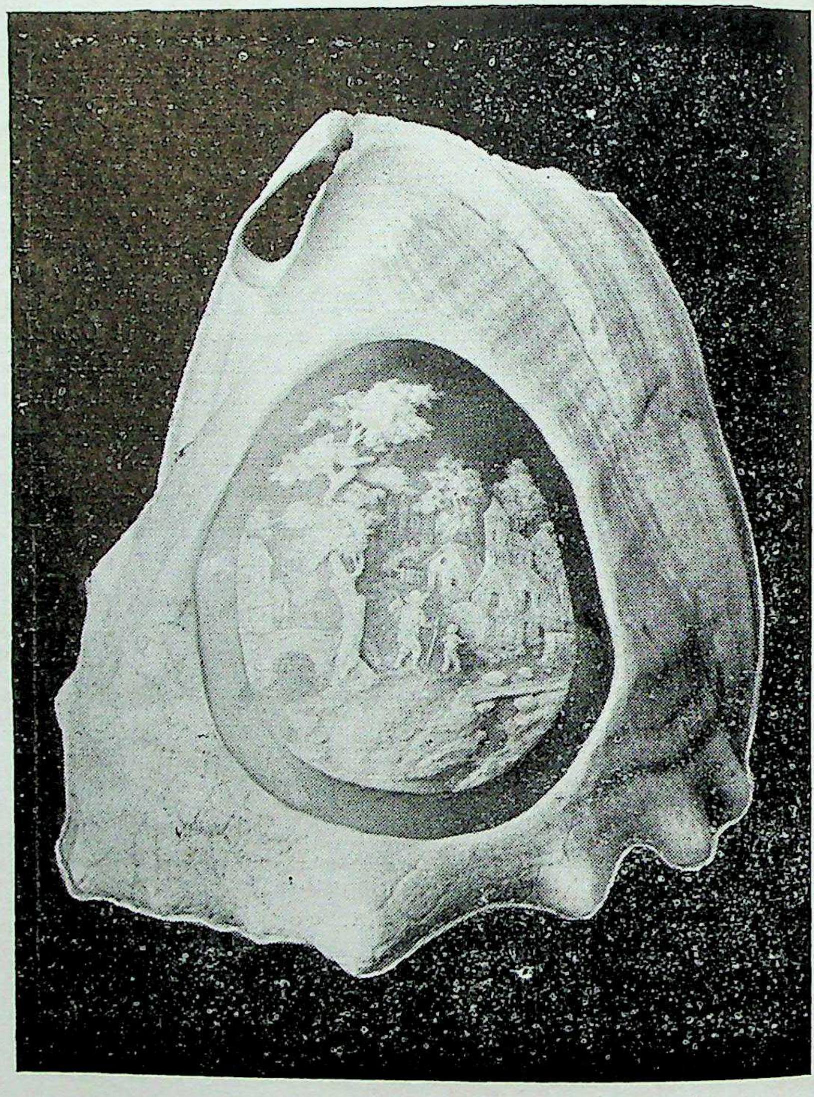

FIG. 27—THE HELMET SHELL (CASSIS MADAGASCARIENSIS) SHOWING CAMEO-CARVING.

In some parts of the world shells have been used as a medium of exchange. Of these the best known is the Money Cowry, *Cypraea moneta*, which is still largely used as currency in parts of West Africa. Among the tribes of North Western America, a species of *Dentalium* was employed as money till recently.

In China and Japan, the translucent shells of the large, flattened, Window Pane oyster (*Placenta placenta*) are ground down, polished and used as window panes instead of glass, and there is a well established " Window Shell " Oyster fishery farm near Trincomalee in Ceylon. The silky byssus of *Pinna*, the Feather shell, has been woven into gloves, caps and stockings, Taranto, in South Italy, being the centre of this curious industry. Indelible dyes have also been extracted from various marine Gastropods, such as *Murex*, *Thais* and *Aplysia*. Apart from these finer uses of shells, they have been valued as a rich source of caclium carbonate and have been employed extensively for the manufacture of lime and in agriculture, for enriching the soil which is deficient in lime.

Phylum ECHINODERMATA.

(*Starfishes, brittle stars, sea urchins, etc.*)

This Phylum includes the starfishes (Class Asteroidea), brittle stars (Class Ophiuroidea), sea urchins, heart urchins, cake urchins, sand dollars, etc. (Class Echinoidea), sea cucumbers (Class Holothuroidea) and the sea lilies and feather stars (Class Crinoidea), besides several extinct groups. They are all radially symmetrical and most of them possess a firm, spiny outer casing or skeleton composed of small, calcareous rods and plates. The Holothurians or sea cucumbers, however, have a soft, slug-like body, with a thick, leathery integument and their symmetry is superficially bilateral, although fundamentally they are also radially symmetrical.

The Echinodermata are exclusively marine and may be found living on the sea shore and on the sea bottom at all depths. They are mostly free living, but are generally sedentary or sluggish in their movements. A few are pelagic. Some species of sea lilies are permanently attached by means of anchoring stalks, but a few (e.g., *Antedon*) swim in the open sea and only temporarily attach themselves to some substratum.

Echinoderms vary a great deal in their form, colour, size and external appearance. Starfishes normally have five arms but the number varies from five to fifty and some may be in the form of pentagonal discs without distinct arms. In the Ophiuroids or brittle stars, the body consists of a small, rounded, central disc with five slender, jointed and flexible arms exhibiting serpentine movements. The sea urchins are globular, hemispherical or elongately ovoid in shape, many of them with long, moveable spines, while the disc urchins or sand dollars are flattened and disc-like, with minute spines. The Crinoids or sea lilies are flower-like, with a cup-like body with five branched arms and the Holothurians or sea cucumbers have elongated, soft, sausage-shaped bodies with a leathery skin and may be variously coloured. Many extinct species, especially those allied to the Crinoids are known from the Palaeozoic rocks.

Representative specimens of most of the common species of each of the five classes of Echinoderms, mostly occurring on South Indian shores and on the reefs in and around the Gulf of Manaar, are exhibited. The exhibits consist of both wet and dry-preserved specimens and are accompanied by descriptive labels and illustrations, wherever necessary.

Subphylum ELEUTHEROZOA.

The mouth is usually on the lower surface and the stalk is absent. This Subphylum includes all Classes of living Echinoderms except the Crinoidea or sea lilies.

Class ASTEROIDEA.

This Class includes the starfishes or sea stars. The body is star-shaped and consists of a flattened central disc with normally five radiating, tapering arms. The arms are not, as a rule, sharply marked off from the disc. The mouth is placed in the centre of the under (or oral surface) and from it a groove radiates along the oral surface of each arm. This groove (known as the *ambulacral groove*) is bordered by many spines and from it many slender processes known as ' tube feet ' protrude in four or two rows. These tube feet serve for locomotion and in the capture and handling of food. The body wall of the starfish is made up of a tough meshwork of small calcareous plates placed close together. Inside the body, there is an elaborate system of canals—the water vascular system—which serves the functions of circulation, respiration and excretion through the amoeba-like free cells that float in the contained fluid. This system opens out to the exterior by means of a sieve-like, perforated plate—the *madreporite*—on the upper or aboral surface. The tube feet are really parts of this water-vascular system and by regulating the pressure of the fluid in the tube feet, the starfish is able to effectively use the tube feet in attaching itself to the substratum or other objects, and in locomotion.

Starfishes are all marine and are generally found on sandy shores or among stones and shingle on coral reefs. They usually spend most of their time attached to some solid substratum and crawl about slowly on the sea bottom to a limited exent. There is no " head ", and the animal can progress in any direction over a surface with equal ease. The starfish feeds on molluscs, crustaceans, tube-dwelling Polychaet worms and other marine invertebrates. Its favourite food appears to be bivalve molluscs. They capture their food by means of their tube feet and most starfish have the habit of everting their stomach and enveloping the prey by applying the inner surface of their baggy stomach over them and slowly digest them. When a starfish begins to feed on a bivalve mollusc, it lies over the prey and applies the tube feet to its shell valves. Gripping the valves by means of its tube feet, it exerts a continued pull over the shell valves which finally yield to the pressure and gape open. The starfish then everts its stomach over the soft body of the bivalve and digests it. On commercial oyster beds, starfish can cause serious havoc by eating large numbers of the oysters. Many starfishes have the power of automatically severing their arms from the disc and regenerating the lost parts.

Several specimens of starfish, including the common, large, robust, multicoloured starfish, *Pentaceros hedemanni*, (Fig. 28) abundant at Pamban and Krusadai, the large, red, thick-spined starfish, *Oreaster lincki* (Fig. 29) common off the coast of Tuticorin, and the common starfish of the Madras beach, *Astropecten mauritianus*, with rather sharply pointed, slender and brittle arms, are exhibited. A single specimen of the large, pentagonal disc-like starfish, *Anthenea regalis* from the Ganjam Coast, in which the disc is large and the arms relatively short, broad and bluntly pointed, being almost merged into the disc, is another notable specimen among the exhibited series of starfish which include, among others

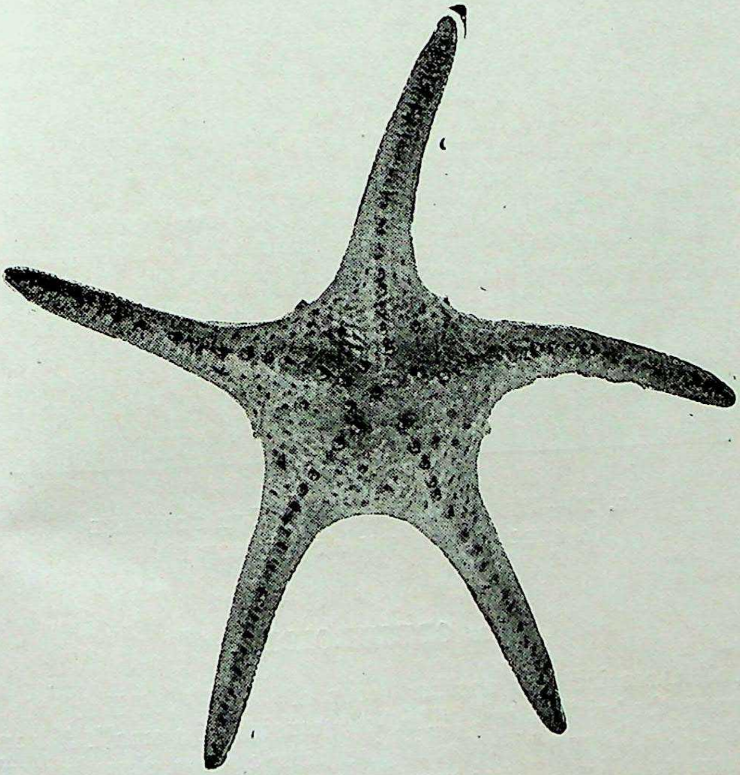

FIG. 28—PENTACEROS HEDEMANNI : THE STARFISH (A SPECIES COMMON AT PAMBAN).

several small, disc-like specimens belonging to species of *polmipes* and *Asterina* common around Pamban. An enlarged coloured illustration showing living starfishes in their natural hues and in their native haunts is also exhibited to illustrate the typical habitat of starfishes.

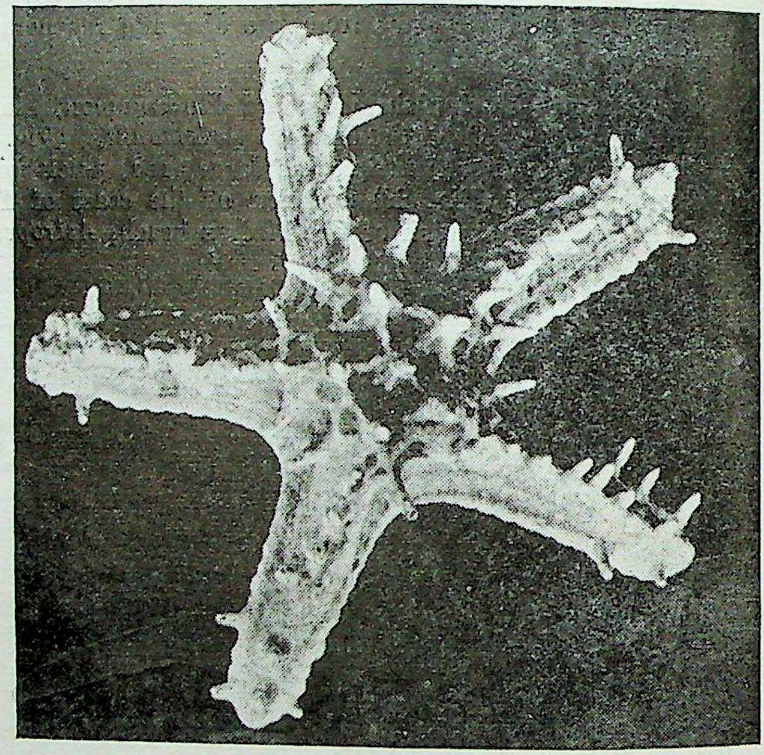

FIG. 29—OREASTER LINCKI : THE STARFISH (A SPECIES COMMON AT TUTICORIN).

Class OPHIUROIDEA.

This Class includes another group of star-shaped Echinoderms known as the brittle stars. The body consists of a small, flattened, rounded disc, from which five distinct arms radiate, sharply marked off from the disc. These arms are slender, jointed and fragile and are capable of sinuous, serpentine movements, being quite flexible. There is no groove on the oral side of these arms and the sieve-like plate marking the entrance to the water vascular system (*madreporite*) is placed on the oral surface. The tube feet are small and without suckers and they are only sensory, aiding in respiration and partly in feeding, but do not help in locomotion. The brittle star moves by pushing and pulling upon the surrounding objects by means of its long, flexible arms. The arms are almost solid and all the digestive and reproductive organs are confined to the central disc-like portion of the body. The stomach is sac-like, but there is no anus, the indigestible waste matter being cast out through the mouth.

Ophiuroids live on the sea bottom in shallow as well as deep water hiding in crevices between stones or sea weed or burying themselves in the mud or sand. They become more active at night. They feed on minute organisms as well as small molluscs and crustaceans and on organic matter contained in the bottom debris. Some species of Ophiuroids are found living as commensals inside the bodies of sponges. They move by rapid sepentine movements of the arms, holding to objects by one or more arms and pushing with the other and thus jerking the body along. They can also swim by means of undulating movements of their arms. The arms break readily and can be cast off easily when the animal is irritated; but they are rapidly regenerated. Ophiuroids in their turn are eaten by fish.

A few species of brittle stars commonly found on the Madras and Pamban beaches are exhibited. Of these, one species, *Ophiothele danae* is common among oysters, etc., attached to piers, wooden posts, etc., and lives in the harbour area in Madras. It is a small species with six arms instead of the normal five.

Class ECHINOIDEA.

This Class comprises the group of Echinoderms popularly known as sea urchins, cake urchins, heart urchins, disc urchins or sand dollars. The shape of the body is varied, and may be spherical, globular, ovoid, cushion-shaped or discoidal. They are without free arms or rays. They possess a shell composed of small, closely fitting calcareous plates and usually carrying numerous slender or thick movable spines. The mouth is on the under or oral surface, and the anus either at the opposite end on the aboral (or upper surface) or somewhere between the mouth and the apical area. Sea urchins are globular or hemispherical in shape while heart urchins are elegantly ovoid and more or less heart-shaped. The sand dollars and disc urchins are flattened and disc-like.

Although there are no arms. five areas (*ambulacra*) corresponding to the five arms are clearly marked on the shell or " test " of the sea urchins in the form of double series of perforations through which a corresponding double series of long, slender tube feet project out. The intervening areas (*interambulacra*) are wider, and sometimes in the form of oval petal-shaped areas (*petaloid ambulacra*), but there are no tube feet in these intervening areas. In the common, true sea urchin (*Stomopneustes*) the shell is very thick and bears numerous tubercles on which are mounted strong, stiff spines which can be moved by means of muscular action

Living members of this Class fall into two main groups or subclasses, namely, (1) the Regularia (or Endocyclica) in which the body is more or less regularly hemispherical and symmetrical and in which the anus is central and placed on the upper or aboral surface, and a masticatory apparatus known as the "Aristotle's lantern" is always present; this group includes the true or regular sea urchins; and (2) the Irregularia (or Exocyclica) in which the anus is marginal on the aboral or oral surface and the body has secondarily assumed a slightly bilateral symmetry. Most of them do not possess an Aristotle's lantern.

Several specimens belonging to common South Indian species representing both these two major groups are exhibited.

Subclass REGULARIA (ENDOCYCLICA).

The exhibits pertaining to this group consist of several specimens of the large black-spined Sea urchin, *Stomopneustes variolaris* (Figs. 30 and 31) which is very common on coral reefs in and around Pamban and Krusadai Island in the Gulf of Mannar. Its very large, thick, black spines are sometimes used as slate pencils. Dried and bleached specimens of the empty white shell

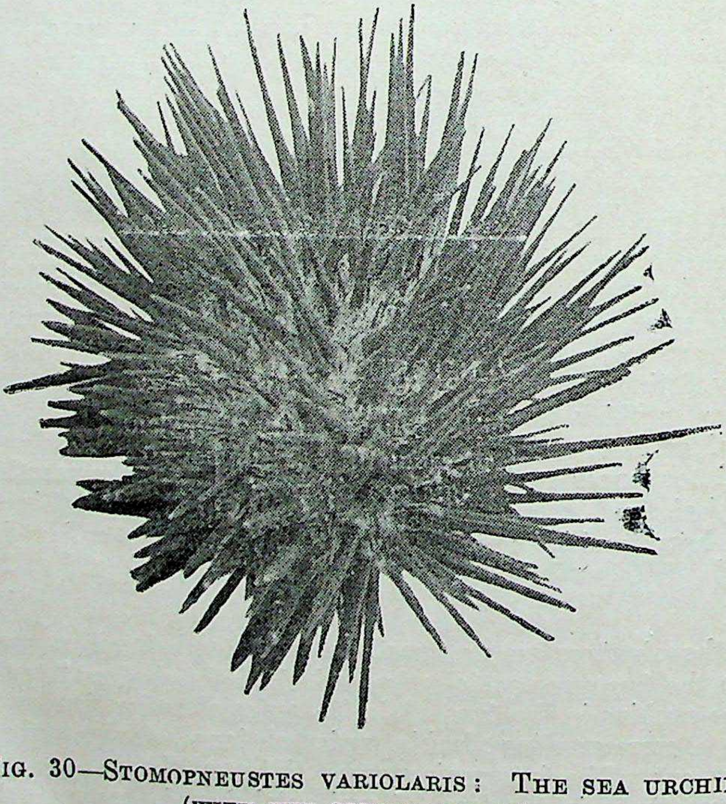

FIG. 30—STOMOPNEUSTES VARIOLARIS: THE SEA URCHIN: (WITH THE SPINES INTACT).

and the masticatory apparatus (Aristotle's lantern) of this species with all its parts disarticulated and labelled are also exhibited. A specimen of *Echinometra mathaei*, with greenish, more slender spines, found at Krusadai; and specimens of *Salmacis bicolor*, with very slender, purplish spines, and *Temnopleures toreumaticus* with a small, globular body and very fine spines are among the other notable exhibits of Regular sea urchins displayed in this gallery.

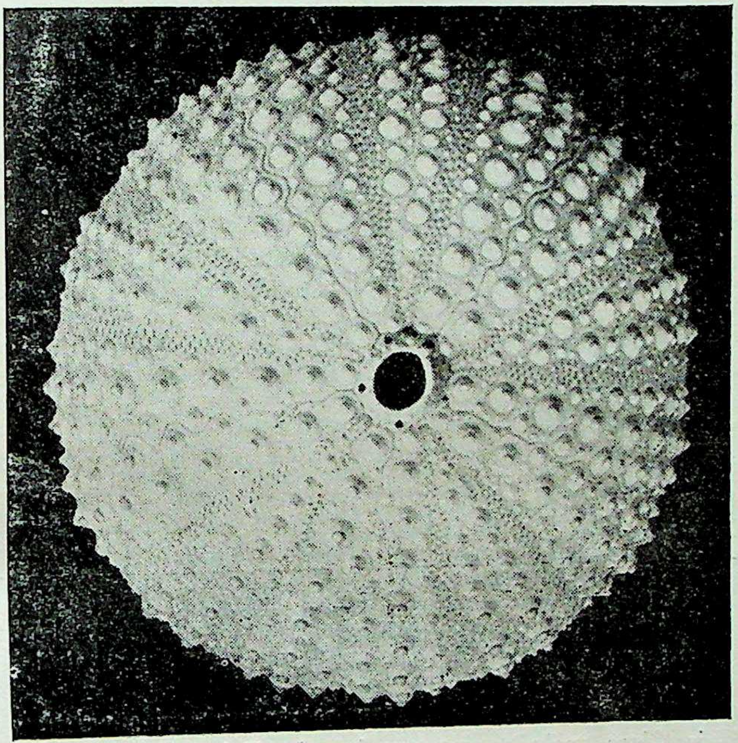

Fig. 31—Test or Shell of the sea urchin: Stomopneustes variolaris: (with the spines removed).

Subclass IRREGULARIA (EXOCYCLICA).

Several specimens of disc urchins, *Echinodiscus bisperforatus*, cake urchins, *Clypeaster* spp., and heart urchins (family Spatangidae, e.g., *Lovenia elongata*) with marked bilateral symmetry, are exhibited both as wet-preserved and dry-preserved specimens. These species are mostly from the sandy shores of Rameswaram, Pamban and Krusadai Island.

Lovenia elongata is a typical heart urchin and is the only species of Irregular Echinoid found alive in the Krusadai Island area on the Kundugal mud flats. Dead shells of the ovoid form, *Echinolampas ovatus* (family Cassidulidae) and of the flattened cake urchins of the species *Clypeaster humilis* (Fig. 32) (family Clypeastridae) are also common in the Pamban area, and a few specimens of these species from Pamban are also exhibited.

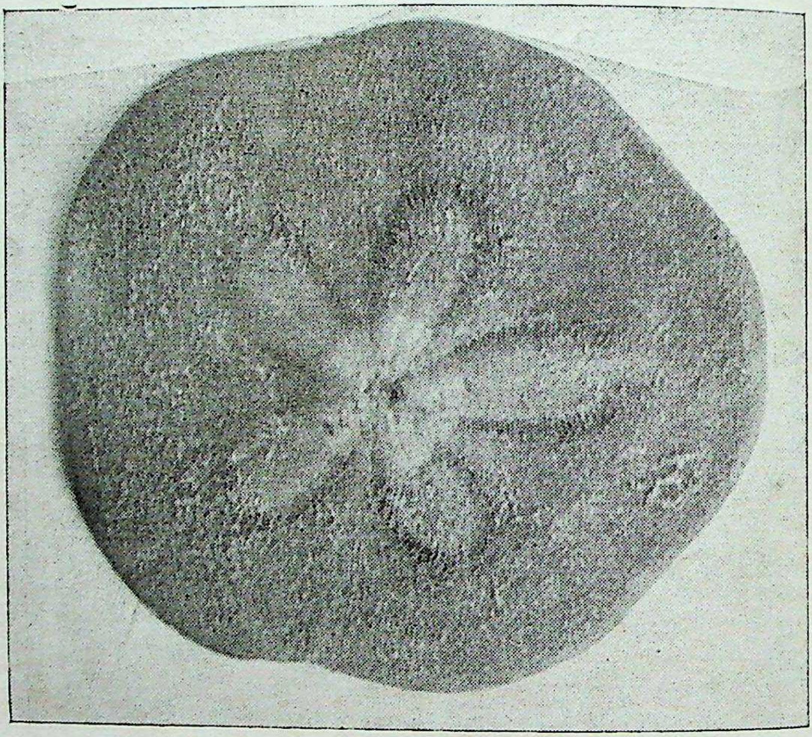

FIG. 32—CLYPEASTER HUMILIS: THE CAKE URCHIN.

Class HOLOTHUROIDEA.

This Class includes sausage-shaped Echinoderms popularly known as the sea cucumbers, with more or less elongated bodies and a leathery integument which contains microscopic, calcareous spicules of different shapes; these spicules are helpful in identifying the species as they assume definite and characteristic shapes in different species. The mouth is situated at the front end of the tube-like body, surrounded by about ten to thirty retractile tentacles, which correspond to the oral tube feet of other groups of Echinoderms. There are no arms, but the penta-radiate symmetry is still indicated by the presence of five longitudinal zones of tube feet along the entire length of the body. The Holothurian habitually lies on one side of the body with the other side (dorsal side) uppermost; this uppermost side bears two rows of tube feet and the other (ventral) side in contact with the substratum bears the remaining three zones of tube feet; thus the animals have secondarily assumed a bilateral symmetry. The tube feet bear suckers and serve for locomotion. The internal structure of the Holothurian is also peculiar in certain respects. There are two structures consisting of a system of elaborately branched tubes, called the *respiratory trees*, and the water pumped in and out of these tubes serves the functions of respiration and excretion. Some Holothurians have a cluster of white, sticky tubes (*Cuverian organs*) attached to the terminal part of the digestive tract. When irritated, these are thrust out and the enemy is entangled by the sticky threads which elongate on contact with sea water. Hence the popular name " cotton spinners " sometimes applied to the Holothurians.

Sea cucumbers are generally sedentary and lie sluggishly on the mud or sand on the sea bed at varying depths or sometimes burrow in the surface mud or sand. They feed on the organic material contained in the bottom debris and move about slowly by the action of the tube feet. When irritated or excited, Holothurians have the habit of eviscerating, i.e., the entire complex of their internal organs are cast out as a defensive device; but the animal is none the worse for it, as it can rapidly regenerate all the lost parts and become normal once again. Economically, some species of sea cucumbers are valuable, as they are edible. In Malaya, China and other parts of the East, the leathery integument of some species of Holothurians is boiled and then dried in the sun to produce the delicacy known as " trepang " or " beche-de-mer " which is used in preparing soup.

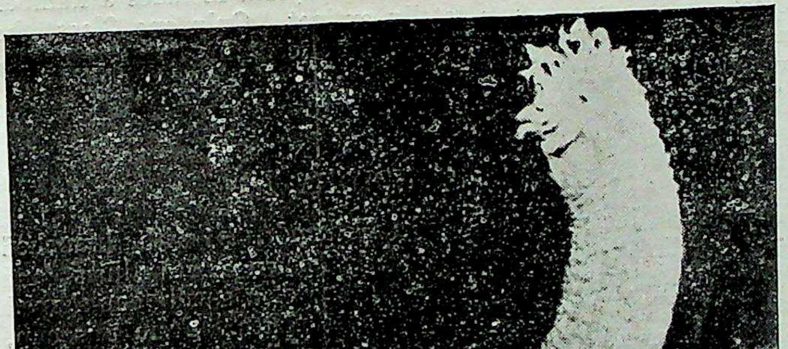

FIG. 33—HOLOTHURIA ATRA: THE SEA CUCUMBER.

Several species of *Holothuria* and species of *Stichopus* and *Actinocucumis* mostly from Krusadai Island, Rameswaram, Pamban and Tuticorin shores are exhibited as wet-preserved specimens. *Holothuria atra* (Fig. 33) is dark puplish brown (almost blackish) in life and often attains a length of almost one foot or even more. It is abundant and widely distributed and is very common on the lagoon on the south side of Krusadai Island. *Holothuria scabra* is another common, but much less abundant species found in the Pamban area, reaching a length of about a foot and is much thicker than *Holothuria atra*, being nearly four inches in diameter. The ground colour of *Holothuria scabra* is variable, ranging from grey to almost black, variegated by transverse yellow streaks. The living colours have faded badly in the preserved specimens exhibited. *Stichopus chloronotus* is another fairly common species which has rows of large, conical tubercles on its body. *Actinocucumis difficilis* is a small species attaining a length of at most about seven centimetres only and is brownish grey in colour during life.

Subphylum PELMETAZOA.

Both mouth and anus are on the upper surface in this group. The body is encased in a cup-shaped skeleton. The animals are usually attached to some substratum either directly or by means of a stalk on the aboral side. This subphylum includes a number of Classes which are to-day totally extinct. Only one Class, the Crinoidea (the sea lilies and feather stars) contains living representatives.

Class CRINOIDEA.

This Class includes flower-like Echinoderms with branched arms resembling feathers and popularly known as sea lilies and feathers stars. The body is in the shape of a small cup-shaped structure or *clayx* composed of calcareous plates. From this cup, five flexible arms radiate and each arm branches into two forming ten even more slender appendages each bearing a number of small lateral branches, and resembling a feather in general appearance. In the sea lilies, the lower surface of the cup bears a jointed stalk which attaches the animal to the sea bottom by means of root-like outgrowths or *cirri*. In the feather stars, however, the stalk is absent, but they anchor themselves by means of a bunch of flexible processes or *cirri*. Both the mouth and the anus are on the upper or oral surface of the disc-like covering of the cup-chaped body (the *calyx cover*). The oral surface of each arm contains a groove—the *ambulacral groove* lined with cilia and beset with numerous tentacle-like tube feet. These tube feet and the cilia serve to procure the microscopic organisms on which the Crinoids feed.

Crinoids live on the sea bottom at all depths from below the low tide mark to depths of over 12,000 feet. They readily cast off their arms or portions of the calyx in self defence, but they can easily regenerate the lost parts. Crinoids are sometimes infested by parasites. The stalked Crinoids or sea lilies, which live attached to the sea bottom by means of their long stalks, are generally gregarious and form extensive under-water gardens. The remaining Crinoids known as the feather stars (e.g., *Antedon*) have no stalk, and can swim about with the aid of their long, flexible, branched arms, but they frequently hold on to objects on the bottom by means of their bunch of cirri. Many living Crinoids are brilliantly coloured in hues of yellow, red, brown or green.

Crinoids were particularly plentiful as fossil forms in the Palaeozoic rocks but only a comparatively few species are found living today, and even these occur mostly in the deeper parts of the ocean. They are rather rare around South Indian shores.

Wet-preserved specimens of the feather star *Antedon sp.* from Tuticorin, showing the oral and aboral aspects of the animal and a very fragile, dry-preserved specimen of the species *Antedon palmata* from Pamban are exhibited. The feathery branched arms are clearly displayed in both these exhibits.

Phylum ARTHROPODA.

This large phylum includes by far the majority of the known species of animals, the individuals of many of the species being numerically very abundant. It includes the crabs, shrimps, lobsters, etc. (Class Crustacea), the insects (Class Insecta), the spiders, scorpions, mites and ticks (Class Arachinda), the millipedes and centipedes (Class Myriopoda) and the primitive Annelid-like forms included in the genus *Peripatus* (Class Onychophora).

The body of a typical Arthropod is bilaterally symmetrical and segmented externally, with some or all of the segments bearing paired appendages of which at least one pair function as jaws. The appendages are all jointed; hence the name Arthropoda, meaning " jointed-foot animals ". The body is covered by a thick, chitinous cuticle which forms an effective exo-skeleton. The nervous system and sense organs are well developed. This is the only major Invertebrate phylum in which most of the species are terrestrial in habit and this phylum contains the only group of Invertebrate animals which are capable of flight, namely, the insects.

Arthropods are very widely distributed and occur at all altitudes on mountains even as high as 20,000 feet and in the ocean depths as far deep as 18,000 feet. They are found in the most varied situations and types of habitat, and different species are variously adapted for life in the air, on land, in the soil, in fresh water, brackish water and in the sea. Some species are parasitic on plants or animals, while some, especially species of insects, have evolved a high degree of social organization and live in colonies.

Many arthropods, particularly crustaceans and insects, are of great economic importance. Many species of crabs, shrimps and lobsters are edible, while a large number of species of insects are injurious to man, either carrying disease or living as pests, feeding on crops, stored food, timber, etc. Some forms such as scorpions and spiders (Arachnids) are poisonous and can produce severe injuries to man and other animals.

The presence of a hard, rigid, chitinous cuticle which covers all parts of the body necessarily limits the size of the animal. Periodical shedding of the external cuticle (moulting or *ecdysis*) therefore becomes necessary to permit the growth of the animal.

The classification of the Arthropoda is complicated. Some recent workers have divided the Arthropoda into a number of Subphyla and each of these in turn into Classes thus—

Subphylum 1—Onychophora : Primative, worm-like Arthropods, with stumpy legs, e.g., *Peripatus*.

Subphylum 2—Trilobita : Extinct, marine forms.

Subphylum 3—Chelicerata : Including the Classes (1) Merostomata, comprising the King Crabs and the extinct Eurypterids, (2) Pycnogonida, the sea spiders and (3) Arachnida, comprising the scorpions, spiders, mites, ticks, etc.

Subphylum 4—Mandibulata : Including the Classes (1) Crustacea, comprising the crustaceans such as crabs, shrimps, etc., (2) Insecta, the insects and (3) Myriopoda, the millipedes and centipedes.

Subphylum 5—Pentastomida : Parasitic degenerate, soft, unsegmented worm-like creatures, including the Linguatulids.

Subphylum 6—Tardigrada : Minute, aquatic or terrestrial creatures known as the Bear animalcules.

However, for purposes of the present handbook, it is far more convenient and simpler to recognize the following main Classes of

Arthropods, and this is in essence, the broad scheme of classification followed by Borradaile and other authors in their latest textbook on the Invertebrata (1963 edition).—

Class 1 —Onychophora—Arthropods with a thin cuticle and a soft muscular body wall, e.g., *Peripatus.*

Class 2 —Trilobita—Extinct marine arthropods with the body divided into three lobes.

Class 3 —Crustacea—Aquatic, semi-aquatic or terrestrial Arthropods with two pairs of feelers; e.g.. Crabs, lobsters, etc.

Class 4 —Myriopoda—Terristrial Arthropods with one pair of feelers and many pairs of walking legs; e.g., centipedes and millipedes.

Class 5 —Insects—Terrestrial or aquatic arthopods with one pair of feelers and three pairs of walking legs. Includes the insects.

Class 6 —Arachnida—Terrestrial and aquatic arthropods with the first appendage in the form of a claw-like pincer (Chelate) and usually with four pairs of walking legs. Includes the spiders, scorpions, mites and ticks, and also the King Crabs.

Selected representative specimens of most of the common South Indian species of arthropods belonging to the above Classes, except the Trilobita which are extinct, are exhibited in this gallery, more or less in the proper systematic order. Where the specimens are too minute or inconspicuous, or where it has been found difficult to secure original specimens, clear, labelled diagrams, photographs or enlarged models with suitable explanatory labels have been exhibited so as to fill up the gaps in the classificatory series and thus maintain a certain amount of continuity in the sequence of the exhibits. Specimens and illustrations to illustrate the economic importance of certain arthoropods, especially insects, their nesting habits, social organization life histories, structure, etc., are exhibited in their appropriate places wherever possbile.

At the commencement of the Arthropod series in this gallery, a series of enlarged diagrams showing the chief characteristic external features of each of the main classes of Arthropoda are displayed with all the parts labelled so as to present a comparative picture of the external morphology of the various classes of arthropods, accompanied by a classificatory label. This series is intended to serve as an introduction to the Arthropodan specimens exhibited in this gallery.

Out of the six classes of arthropods enumerated above, the Trilobita are extinct and are not represented by any specimens in the gallery. Specimens of the Classes Onychophora and Myriopoda are exhibited in the vertical part of the cases installed in the corner at the right extreme end of the gallery immediately adjoining the passage leading to the Fish gallery. These two groups are represented only by a comparatively very few specimens, and may be conveniently dealt with first in the present account. The other three main classes are much larger groups and occupy by far the greater proportion of the exhibition space in this gallery and will be described in the following sequence in which they are arranged in the gallery: (1) Crustacea; (2) Insecta; and (3) Arachnida.

Class ONYCHOPHORA.

This class includes primative, worn-like arthropods, with a soft, thin cuticle and a series of short, stumpy walking legs. The head is not marked off from the rest of the body and bears one pair of feelers, one pair o f jaws and one pair of tubercle-like structures —the oral papillae.

The members of this group are rather uniform in structure and are zoologically of great interest are they show many Annelidan characters—features which connect the Arthropoda with the Annelida to which the Arthropods, in fact are most closely related in the general plan of their organization.

These animals live in dark, moist places, in rock crevices and under logs of wood, rotting timber or under stones. They bear a superficial resemblance to other crawing animals like earthworms and millipedes and they have preserved several primitive features. They require a moist atmosphere and are exteremly susceptible to drought. They avoid light and are cryptic in their habits and are thus rarely seen in their native habitat. They move about slowly and deliberately, feeling their way through by means of their extremely sensitive feelers. When irritated, they forcibly eject the contents of their slime vesicles from their oral papillae. They use this as a defensive device. They are carnivorous, feeding on wood lice, termites, etc. Almost all species are viviparous.

Peripatus is the sole major genus of the group and comprises about sixty to seventy species showing marked discontinuous geographical distribution. These species fall into several distinct groups according to their geographical distribution, designated by distinct generic names such as *Neoperipatus*, *Congo-peripatus*, *Austro-peripatus*, etc. The only genus found in India is *Typhloperipatus*, and a single small specimen of *Typhloperipatus* sp. is exhibited as a wet-preserved specimen.

Class MYRIOPODA.

The Myriopoda include the Centipedes and the Millipedes. They have a long, slender body, with a distinct head, bearing a single pair of feelers, a pair of jaws (mandibles) and one or two pairs of maxillae. The trunk is long and segmented and each segment bears one or two pairs of walking legs. This class is divided into four sub-classes, but most of the common and more familiar forms belong only to the following two main sub-classes and the exhibited specimens of this class also belong only to these two major sub-divisions :—

(1) Sub-class Chilopoda (including the Centipedes); and
(2) Sub-class Diplopoda (including the Millipedes or the "thousand-legged worms" as they are sometimes known).

Sub-class I—CHILOPODA.

This sub-class comprises the Centipedes. They have a long, slender, segmented, dorso-ventrally flattened body. The head bears a pair of long feelers, conspicuously jointed. The first segment of the body bears a pair of four-jointed poison claws and on each of the other segments except the last two there is a pair of small, seven-jointed walking legs. The genital opening is situated at the hind end of the body.

Centipedes are poisonous creatures and are mostly carnivorous, preying chiefly on insects and earthworms. They easily kill their prey by poison exuding from a duct in the poison claw and the prey is then chewed by the mandibles. Centipedes occur mostly in the warmer countries, hiding under stones and logs of wood during the day and becoming active during the nights. Some species are oviparous while others are viviparous. Some centipedes in the tropics may attain a length of nearly eight inches and their poisonous bite can be extremely painful and even prove fatal to man.

A few specimens belonging to the most common and familiar South Indian species are exhibited. Of these, *Solopendrella subspinipes* is the largest and most conspicuously coloured with bright transverse bands. *Scutigera* is another common form with a short and thick body and with fifteen pairs of extremely long, slender legs, increasing in length posteriorly. These are agile centipedes which prey on insects, but are harmless to man.

Sub-class II—DIPLOPODA.

The millipedes (or the so-called " thousand-legged worms ") are including in this sub-clause. They are chiefly distinguished from the Centipedes in having cylindrical bodies, in the segments of the body bearing each two pairs of walking legs and in the genital opening being situated far forwards, on the 3rd segment, behind the head. The trunk is differentiated into an anterior "thorax" consisting of four segments and a posterior region (abdomen) consisting of double segments, each with two pairs of legs. The external skeleton of the body is usually rigid, being strengthened by limy deposits. Many species are brightly coloured.

Millipedes inhabit humid, dark places and are usually found hiding beneath stones or rotten logs of wood. They move slowly, and the numerous legs seem to move in a series of waves from the hind end forwards as it moves along. They feed on dead vegetable matter and also on animal matter. In South India there are about three or four species which are particularly common and are most abundant during and after the rains, when they may be seen in large numbers crawling about on wet mud and amidst dead foliage in gardens and compounds. Some species roll themselves up into a spiral coil when disturbed. Millipedes are found all over the world, but the largest and most colourful species are confined to the tropics.

Specimens of three common Madras species are exhibited. They include the large, dark red, robust species, *Thyropygus nigrolabiatus* which attains a length of four to five inches and two smaller forms, *Chondromorpha severini* and *Xenolobus carnifex*. The latter is the small red millipede with a black median longitudinal stripe along its back. A dark, blakish green millipede with rows of prominent bright yellow spots along the sides (*Polydesmus* sp.) also occurs abundantly in Madras during the monsoon.

Class CRUSTACEA.

The Crustacea constitute a large and important class of Arthropods and are mostly aquatic in their habit being adapted for an aquatic mode of respiration. They include a host of widely differing forms such as the water fleas, fairly shrimps, barnacles crabs, prawns, lobsters and their allies. Most of them are marine, but many species inhabit freshwater ponds and tanks, and a few are terrestrial.

The chief distinguishing characters of Crustaceans are as follows : the body is composed of (1) a head formed of five fused segments with two pairs feelers (antennae) and one pair of mandibles (jaws); (2) a thorax composed of 2 to 60 segments either distinct or variously fused; and (3) and abdomen with numerous segments usually distinct.

Crustaceans often have a shield-like covering or carapace over the head and parts of the throax, either in the form of a dorsal plate or two lateral valves. There are numerous appendages which are variously modified. Respiration is normally carried on by means of gills. The sexes are separate (except in the Cirripedia and in some parasitic Isopods).

The Lobster (or Crayfish) is a typical large-sized example of a Crustacean and serves as a suitable introductory exhibit for the Crustacea. A dry-preserved specimen of the Spiny Lobster, with all its external parts individually labelled, is therefore exhibited; this will help in understanding the salient external features of the external morphology of a typical Crustacean.

By far the great majority of Crustaceans are free-living; some are gregarious and occur in enoromous " schools ". The barnacles are sedentary Crustaceans, being attached to some substratum and look more like shell-bearing molluscs, or they may even be parasitic. Certain other Crustaceans such as Isopods are also commensal or parasitic on various aquatic animals. Some parasitic species are so profoundly modified that they scarcely look like a Crustacean at all. Most marine Crustaceans pass through several larval stages, the younger ones of which are quite unlike the parent animals.

The Crustacea are divided into the following main Subclasses and Orders. Typical representative specimens belonging to common South Indian species included in most of these major groups are exhibited mostly as wet or dry-preserved specimens. Where the specimens are too small or fragile, or where they are not easily available or suitable for display, clear explanatory diagrams with descriptive labels are put up to represent such groups and to fill up the gaps in the systematic series, so as to maintain the continuity in the taxonomic sequence—

Subclass I—Branchiopoda.—Free-living, mostly freshwater Crustaceans with compound eyes (e.g. water fleas, etc.).

Subclass II—Ostracoda.—Minute Crustaceans with bivalved carapace.

Subclass III—Copepoda—Free or parasitic, small, or microscopic Crustaceans, without compound eyes.

Subclass IV—Branchiura.—Flattened Crustacea with compound eyes, parasitic on fish. They are known as "Carp louse".

Subclass V—Cirripedia—Fixed, mostly hermaphrodite Crustaceans, without compound eyes in the adult state. Includes the Barnacles.

Subclass VI—Malacostraca.—This Subclass includes the Higher Crustacea with compound, usually stalked eyes, and a carapace covering the thorax. The thorax is composed of eight segments and the abdomen of six (or rarely seven) sagments. Includes Lobsters, prawns, crabs, etc., and also some lower groups such as Sand hoppers, Wood lice, etc.

Subclass I—BRANCHIOPODA.

This group includes small, minute or microscopic, free-living Crustacea, with compound eyes and usually with a carapace. There are at least four pairs of thoracic appendages which are in most cases broad, leaf-like and margined by gills. There are no abdominal appendages. These are mostly freshwater Crustacea. This group includes several Orders and common species of each of these Orders are illustrated by well labelled enlarged explanatory diagrams, as the specimens themselves are too small for display. The Order Cladocera includes the Water flea, *Daphnia obtusa*, which is illustrated by a diagram. Water fleas are minute freshwater Crustaceans usually with a bivalved carapace which does not enclose the head.

Subclass II—OSTRACODA.

These are minute, bilaterally compressed Crustaceans, with a bivalved carapace which encloses the entire body. Only two pairs of thoracic appendages are present. This Subclass also comprises several Orders, but a diagram of *Achtheres percarum*, a gill parasite of the perch and the trout, belonging to the Order Podocopa alone is exhibited to represent this Subclass.

Subclass III—COPEPODA.

This group includes mostly small to microscopic, either free-living or parasitic Crustaceans of variable form, without compound eyes or carapace, and typically with six pairs of thoracic limbs. There are no legs on the abdomen, but the abdomen carries eggs in the female. The species are either marine or freshwater.

Free-living Copepods are aquatic Crustacea of minute size, but often so abundant as to form one of the most important sources of food for carnivorous fishes. They are thus of very great economic importance.

Parasitic Copepods often attain a comparatively larger size, but are necessarily much less abundant. They belong to a number of different groups, are modified to varying degrees and exhibit great diversity in their life history and structure. The males are usually smaller, often very much smaller than the females and usually retain more of their Copepod characters. Usually they are free-swimming, but some live in a dwarfed condition attached to the female.

The eggs may be deposited singly, but are usually carried in a single or paired pocket on the sides of the abdomen in the female.

Diagrams of a few selected species of free-swimming and parasitic Copepods, representing the various families and suborders of this group are exhibited with explanatory labels.

Subclass IV—BRANCHIURA.

This Subclass includes Crustacea with a flattened, disc-like body and compound eyes. They are temporarily parasitic on fishes, both in fresh and salt water and are popularly known as Carp lice ". They possess a suctorial mouth and carapace-like expansions of the head and an unsegmented abdomen devoid of appendages. Formerly this group was included as an Order under the Copepoda. A diagram of *Argulus foliaceus*, a common species of carp louse, is exhibited to represent this Subclass.

Subclass V—CIRRIPEDIA.

This group comprises sessile (i.e., fixed) Crustaceans, popularly known as Barnacles. In this group, although the larvae may be free-swimming, the adults are sesile, attached or parasitic. The carapace becomes a mantle round the body and usually bears calcareous plates. They are for the most part hermaphrodite, without compound eyes in the adult. There are typically six pairs of thoracic appendages behind the mouth and these are used in gathering food. The abdomen is reduced and vestigial.

Barnacles may be seen in enormous numbers on rocks or wooden posts by the sea shore that are submerged by the tide. The shelly plates which cover the animal are strong enough to protect the animal from drying up when the tide recedes. Stalked barnacles (e.g., the Goose barnacle, *Lepas anserifera*) are less well protected, but are common on floating timber, on which they may often be found dead or dying, when it is washed up on the shore. Some barnacles attach themselves to the carapace of trutles (e.g., *Chelonobia* spp., others to the tails of sea snakes and yet others live in sponges. Some have become highly specialized parasites.

The larval stages of barnacles are free-swimming. The initial stages (*Nauplius* and *Metanauplius*) develop finally into a "*Cypris*" stage with a bivalve shell which settles down and gets attached to some substratum. After this, the adult form is gradually assumed.

Brancles develop with great rapidity. They settle in large numbers on the submerged parts of ships from which they have to be scraped to prevent loss of speed by the increased friction which they cause when the vessel is moving.

Specimens belonging to some of the common South Indian species of stalked and sessile barnacles are exhibited. The sessile barnacles exhibited include *Balanus tintinabulum* and *Chelonobia testudinaria* (Fig. 34). The latter is an oval, convex form found attached to the carapace of turtles. The stalked barnacle exhibited is *Lepas* sp. popularly known as the Goose Barancle.

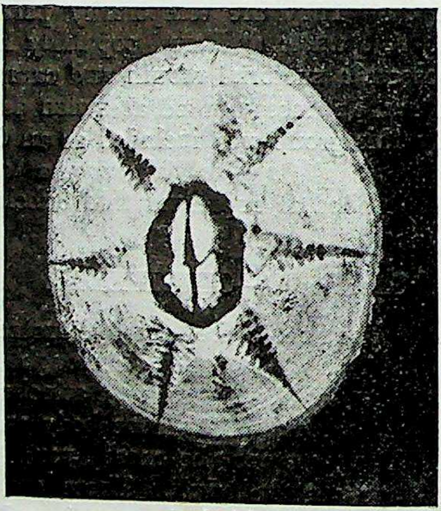

FIG. 34—CHELONOBIA TESTUDINARIA: THE TURTLE BARNACLE.

This Subclass is divided into a number of Orders of which the Order Rhizocephala is specially interesting as it includes parasitic forms which have degenerated to such an extent that they have lost the normal Crustacean structure. A typical example is *Sacculina*. The body is sac-like, without any appendages, but with absorptive roots penetrating the body of the crab on which it is parasitic. A diagram to illustrate the morphology of a Rhizocephalan compared with that of a normal Cirripede is exhibited.

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Subclass VI—MALACOSTRACA.

This Subclass includes the more highly organized groups of Crustacea comprising the labsters, prawns, shrimps, crabs, etc., besides many smaller and less familiar forms such as the Sand hoppers, Wood lice, etc. They possess compound eyes, usually borne on stalks and typically, a carapace covering the thorax. The body is, as a rule, composed of 19 segments, of which five form the head, eight the thorax and the remaining six the abdomen. Rarely, the abdomen is composed of seven segments. The head is fused to one or more thoracic segments. All the six abdominal segments bear appendages.

The Malacostraca are divided into a number of divisions and Orders of which mention may be made here only of the more important ones which are represented by exhibited specimens and diagrams in this Gallery. Many of these groups comprise small and inconspicuous species not suitable for display. Most of the specimens exhibited belong to the Order Decapoda, comprising the prawns, crabs and lobsters since the species included in this Order are very numerous and are abundantly represented on the South Indian shores.

Order NEBALIACEA.

The carapace is bivalved. The abdomen is composed of seven segments while in all the remaining Orders that follow, the abdomen is composed only of six segments. They are small marine Crustaceans reaching a length of 12 mm. An enlarged diagram of a female of *Nebalia bipes* is exhibited.

Order ANASPIDACEA.

These have no carapace. They are confined to the freshwaters of Australia. An enlarged diagram of the side view of the female of *Anaspides tasmaniae* is exhibited.

Order MYSIDACEA.

This group includes small, mostly marine, and usually pelagic Crustaceans, popularly known as the "Opossum Shrimps". The carapace covers most or all of the thoracic segments. The eyes, when present, are stalked. They are mostly carnivorous. An enlarged diagram of the typical species, *Mysis relicta*, is exhibited to represent this group.

Order CUMACEA.

This Order includes small, mostly marine organisms burrowing in sand or mud. The carapace bears two anterior plates often joined and produced over the head. The abdomen is slender,

Order TANAIDACEA.

This group includes mostly minute, marine Crustaceans inhabiting burrows or tubes. The carapace is small. Eyes, if present, are borne on short, immovable stalks. They are found in the ocean up to a depth of about 12,000 feet. An enlarged diagram of the female of a typical species, *Apseudes spinosus*, is exhibited to represent this Order.

Order ISOPODA.

The Isopoda are a large group Grustacea exhibiting much variety. They are popularly known as Pill Bugs and Wood Lice. The body is usually depressed dorso-ventrally and there is no carapace. The eyes are not stalked. They are found in salt or freshwater, among plants or under stones. Some are terrestrial and many are parasitic on fishes and other Crustaceans and show much degeneration in their structure. The large marine Isopod, *Ligia exotica* is widely distributed and is abundant on boats. A specimen of this species, and another specimen of the parasitic Isopod *Bopyrella thomsoni*, together with diagrams of one or two other species are exhibited.

Order AMPHIPODA.

This group includes small Crustaceans, popularly known as the Sand hoppers, which are often abundant on the sandy beaches especially where the coast is strewn with large quantities of drift sea weed. The body is without a carapace and often laterally compressed. The abdomen is flexed ventrally between the third and fourth segments. They are mostly marine, but a few species inhabit freshwater. One species is parasitic on whales (the Whale louse, *Cyamus*). The slender-bodied forms are abundant on sea weeds, hydroids, etc., around Pamban. A wet-preserved specimen of one of these species, *Caprella* sp., from Pamban, and an enlarged diargram of another typical species, *Gammarus locusta*, are exhibited.

Order STOMATOPODA.

This Order belongs to a separate division of the Malacostraca and includes the more advanced forms known as the Mantis Shrimps. They are marine and are found on the sea bottom in the sand or in crevices of stones and rocks. They are known as Mantis Shrimps on account of the peculiar, knife-like folded form of the second pair of thoracic legs which somewhat resemble the front legs of the praying mantis. Some species are edible Specimens of a common Madras species of *Squilla*, viz., *Squilla raphidia*, one of *Gonodactylus glabrus* from Krusadai, and two specimens of the much larger *Lysiosquilla* sp. (one wet and the other dry-preserved) are exhibited.

Order DECAPODA.

This group belongs to yet another major division of the Malacostraca and is the most highly advanced among the Crustacea. It includes all the larger and more familiar Crustaceans such as crabs, prawns, shrimps and lobsters. The members of this Order are characterised by the presence of five pairs of "walking legs" some of which may be used for grasping. The whole of the thorax bearing these legs and the appendages in front of them is covered by a single shell-like shield or carapace. They are mostly marine, but some are freshwater and a few are terrestrial. Many species are edible and are economically important.

This Order is divided into three more or less distinct groups or Suborders and selected representative specimens of many of the important South Indian species of all these three groups are exhibited both as dry-preserved and wet-preserved forms. The three groups are as follows :—

(1) Macrura (Shrimps, prawns, lobsters, etc.);
(2) Anomura (Mole crabs and Hermit crabs); and
(3) Brachyura (True crabs).

Suborder MACRURA.

This group is divisible into two subdivisions, namely, Macrura Natantia, comprising the shrimps and prawns, and Macrura Raptantia, comprising the lobsters.

MACRURA NATANTIA.

(*Shrimps and Prawns*).

These are long-tailed, swimming Decapod Crustacea and are mostly edible. The body is more or laterally compressed and the abdomen is well developed. The abdominal legs function as powerful swimming appendages. Shrimps (Penaeidea) may be distinguished from prawns (Caridea) by the pleura of the second abdominal segment which overlap those in front in the latter, but not in the former; by the third legs which are always chelate (unless much reduced) in the former, but never in the latter; by the gills which are dendrobranchiate (i.e., branched and tree-like) in the former and phyllobranchiate (flattened and leaf-like) in the latter; and by various other less conspicuous characters.

Both shrimps and prawns usually pass through a series of more or less extensive larval stages after leaving the egg. This is most complete in some of the shrimps which hatch in the "Nauplius" stage, with only one median eye and three pairs of appendages. The Nauplius develops into a Zoea larvae with paired eyes and a broad cephalothorax and slender abdomen; the Zoea in its turn develops into a "Schizopod" stage by transformation of its rudimentary thoracic appendages into regular biramous swimming limbs. The Schizopod stage grows more or less directly into the adult.

The life history of the prawn, *Penaeus*, is illustrated by an explanatory diagram. Several wet and dry-preserved specimens of prawns belonging to common South Indian species, including *Palaemon carcinus* (Fig. 35) and *Penaeus indicus* are exhibited.

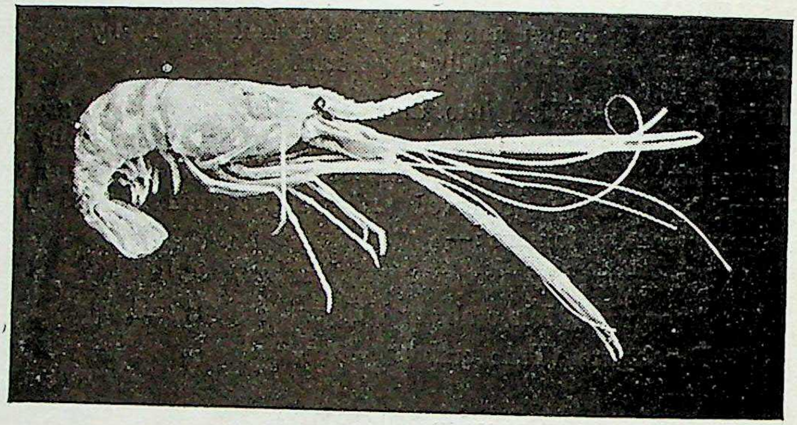

FIG. 35--PALAEMON CARCINUS : THE PRAWN.

Several species of *Alphaeus* occur in and around Krusadai Islands; they are remarkable for the sharp, clicking sound they produce by means of their enormous claws during life. Two specimens of *Alphaeus strenuus* from Krusadai Island are exhibited. The larger species such as *Palaemon carcinus* and *Penaeus indicus* and several other species of prawns and shrimps are highly edible and are therefore commercially valuable.

A specimen of the small shrimp, *Periclimenes brevicarpalis* from Krusadai Island is also exhibited in the present series as an interesting example of symbiosis. A number of different species of prawns are known which live in close association with other animals, but without any apparent parasitic association. *Periclimenes brevicarpalis* is, for instance, always found on the disc of giant sea anemones (especially *Stoichachtis giganteum*). It is transparent and practically colourless when alive, except for a pattern of opaque yellow patches which resemble flakes of broken shell which have drifted on to the anemone. In spite of its comparatively large size, therefore, it is by no means easy to distinguish it in its natural location. Why the anemone makes no attempt to catch and eat it is not known.

A much smaller species of the same genus, *P. spiniferus*, lives in association with Madreporarian corals; and a number of other Crustacea are likewise associated with other organisms.

MACRURA RAPTANTIA.

(*Lobsters.*)

In this group the body is not laterally compressed and the abdomen is well developed. There is a broad tail fin formed by the expanded terminal appendages. This group includes large Crustacea such as lobsters and crayfishes. Three species of Spiny lobsters occur on the Madras and Pamban Coasts. Of these, large, dry-preserved specimens of *Panulirus dasypus* and *Panulirus ornatus* from Madras, Krusadai and Kilakarai are exhibited, two of them in wall cases and one in a sloping show case. In the latter specimen (of *Panulirus dasypus*) all the external parts are individually labelled to illustrate the external morphology of a typical Decaped Crustacean (Fig. 36). *Panulirus ornatus* attains a very large size, the specimen from Kilakarai exhibited in this gallery being 4½ inches across the carapace and 1½ feet long, or even

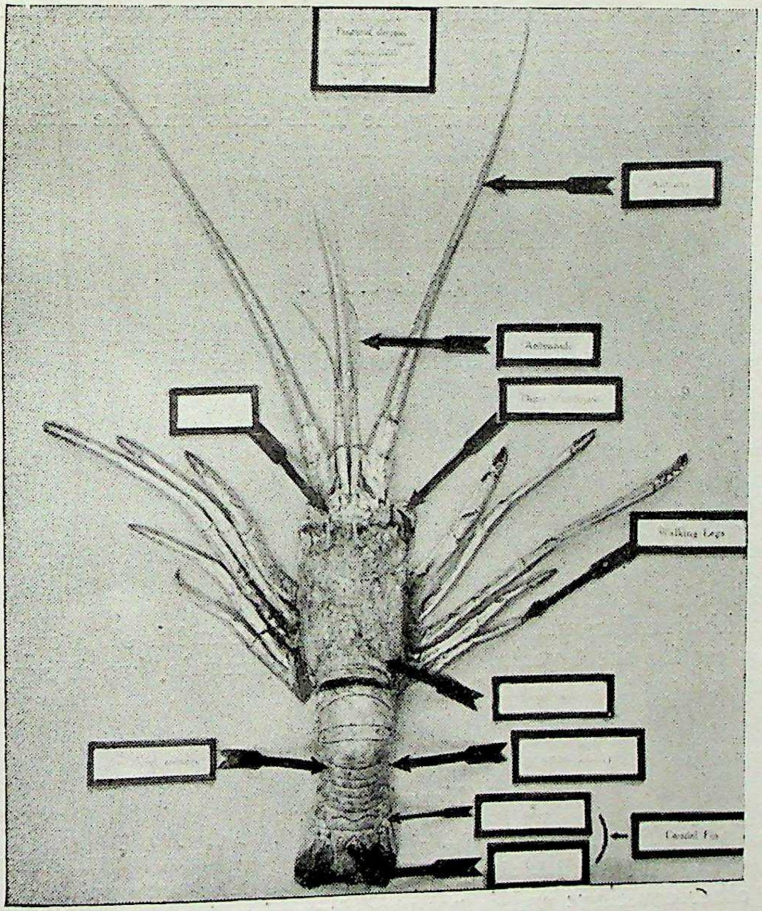

FIG. 36—PANULIRUS DASYPUS: THE SPINY LOBSTER (WITH THE PARTS LABELLED).

more than double that length if the antennae are included. Only dead, empty shells of the lobster have been collected from the beaches in and around Krusadai Island. Lobsters are generally brightly and ornately coloured during life and they usually live on the rocky sea bottom, feeding on worms, snails, fishes and other crustaceans. They are highly edible and considered a delicacy in most parts of the world. The larva of the Spiny lobster is known as the Phyllosoma larva,, an illustration of which is exhibited in the sloping show case beside the adult dry specimen.

Suborder ANOMURA.

This group is intermediate between the Macrura (prawns and shrimps) on the one hand and the Brachyura (crabs) on the other and exhibits a great variety of forms. The trunk legs of the last pair are weak and not used in locomotion or for catching hold of prey. The abdomen is usually bent under the thorax.

The Anomura are divided into two distinct groups—the Anomura Hippidea comprising the Mole crabs and the Anomura Paguridea including the Hermit crabs, and selected specimens of common species of both these groups are exhibited.

ANOMURA HIPPIDEA.

(*Mole crabs*).

In this sub-group, the end segments of the 2nd to 4th trunk legs are curved and flattened, and the abdomen is symmetrical and bent under the thorax. Specimens of both the common species of Mole crabs occurring on the Madras Coast, namely, *Emerita asiatica* (formerly known as *Hippa asiatica*) and *Albunea symnista*, are exhibited. They inhabit the sandy shores and are burrowing in habit. *Albunea symnista* (Fig. 37) lives below the low tide mark and bears very long antennae which, when opposed together, form a long, narrow tube which serves for respiration when the animal is buried in the sand. *Emerita asiatica* (Fig. 38) is pinkish in colour and lives between tide marks and is often exposed to view for short periods when the waves recede, but it rapidly burrows again in the sand and hides itself.

ANOMURA PAGURIDEA.

(*Hermit crabs*).

In the Hermit crabs, the sixth abdominal limb, when present, is adapted for holding the body in the shell of a gastropod mollusc or other covering; and is not used for swimming. The abdomen is almost always asymmetrical, soft and twisted, or bent under the thorax. Hermit crabs occupy the empty shells of gastropod molluscs, their soft abdomen being twisted to fit the spirally twisted interior of the shell cavity. The shell provides adequate protection to the hermit crab, especially to its soft and vulnerable abdomen. The last two pairs of thoracic appendages are also reduced and adapted for carrying the shell.

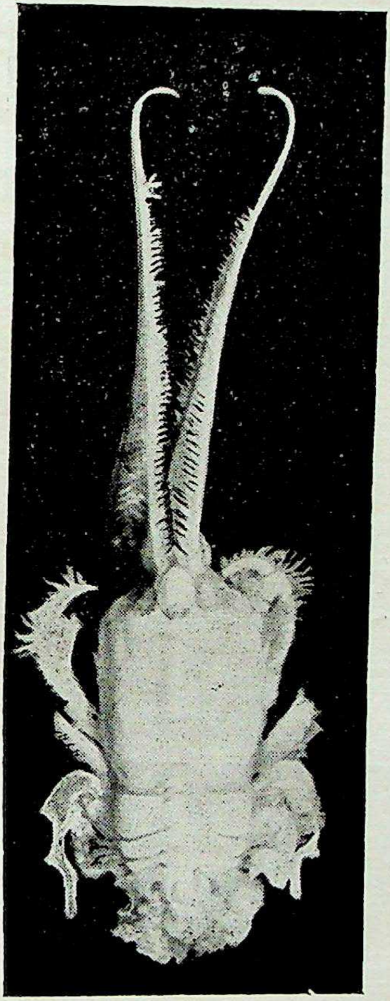

FIG. 37—ALBUNEA SYMNISTA: THE MOLE CRAB.

In addition to carrying the shell, many hermit crabs also have sponges, sea anemones, worms, etc., living with them in close association. These associations are examples of commensalism and are mutually advantageous to the animals concerned.

Several species of hermit crabs occur around Madras and Pamban Coasts, and are common especially between tide marks on the reefs. Wet-preserved specimens of *Pagurus setifer* (family Paguridae) from Pamban, and *Coenobita rugosus* (Fig. 39) (family Coenobitidae) from Krusadai Island, together with a photograph of another species of the family, *Eupagurus bernhardius*, are exhibited to represent this group.

The family Coenobitidae also includes the very large and remarkable Robber crabs or Coconut crabs, a fine specimen of which is exhibited separately in an adjoining case preserved as a

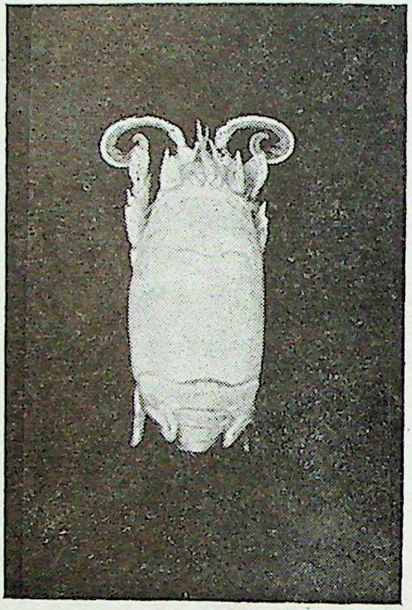

FIG. 38—EMERITA ASIATICA: ANOTHER SPECIES OF MOLE CRAB.

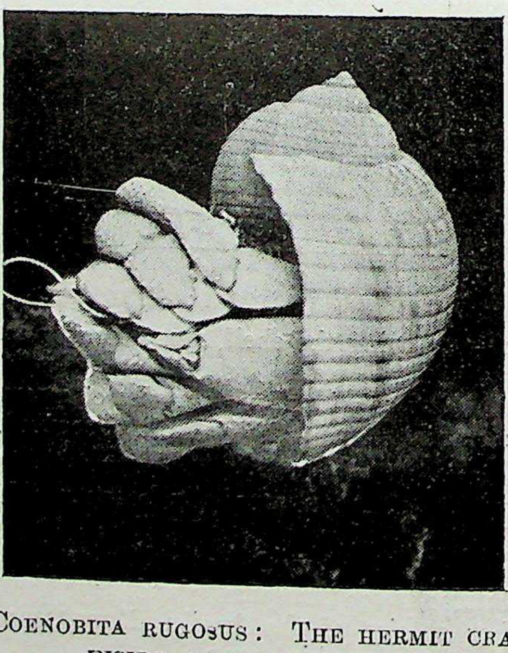

FIG. 39—COENOBITA RUGOSUS: THE HERMIT CRAB (*in situ*) INSIDE GASTROPOD SHELL.

wet mount. The Coconut crab or Robber crab, *Birgus latro* (Fig. 40 and 41) is a gigantic air-breathing Pagurid crab, often more than a foot in length. It lives on land, often sheltering in holes and crevices in the ground, near the coasts of many coral islands in the Indian and Pacific Oceans where coconut trees abound. The crab ascends the trees for picking the nuts. It feeds on the kernel of the coconut which it extracts by hammering on the eye-hole of the coconut with its heavy claw until room is made for the small claw to enter and extract the kernel. It also uses the husk of the coconut to line its burrow.

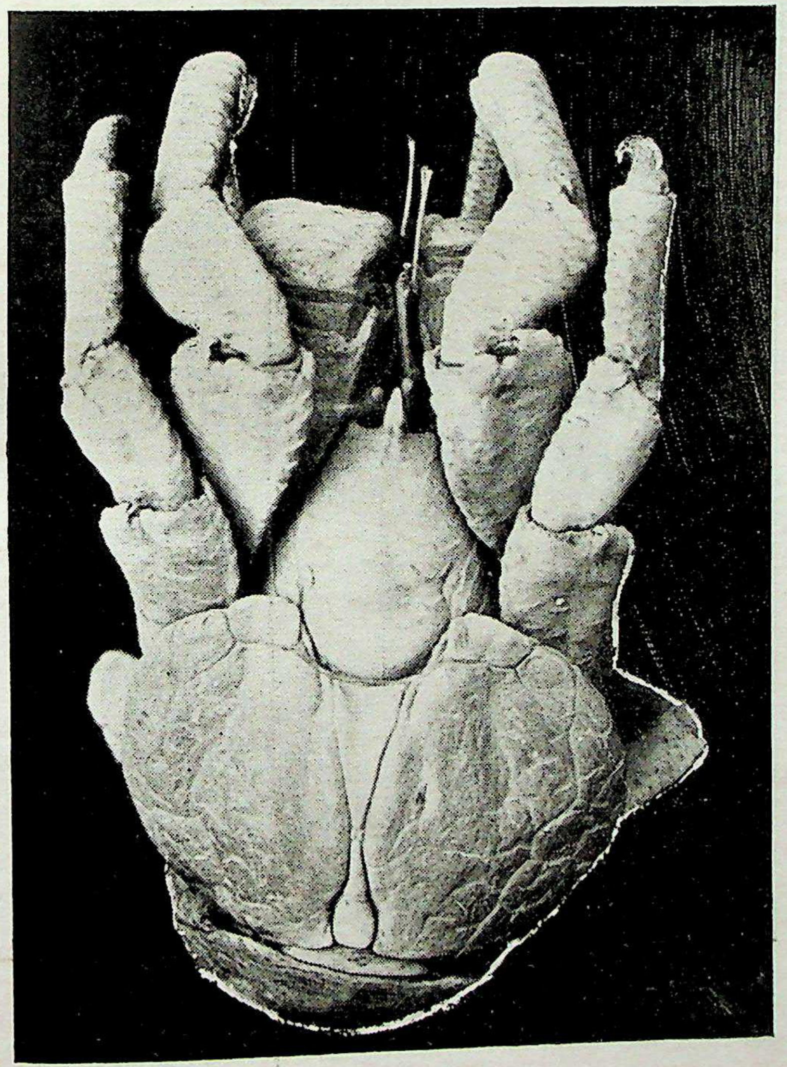

FIG. 40—BIRGUS LATRO: THE COCONUT CRAB OR ROBBER CRAB; (DORSAL VIEW).

The Nicobar Islands have devised an ingenious method of trapping the Robber crab. They tie tufts of grass to the trunk of the tree at a considerable height from the ground. The crab, as it descends down the tree feels the tufts of grass and lets go its hold under the impression that it has reached solid ground and falls down to meet its end.

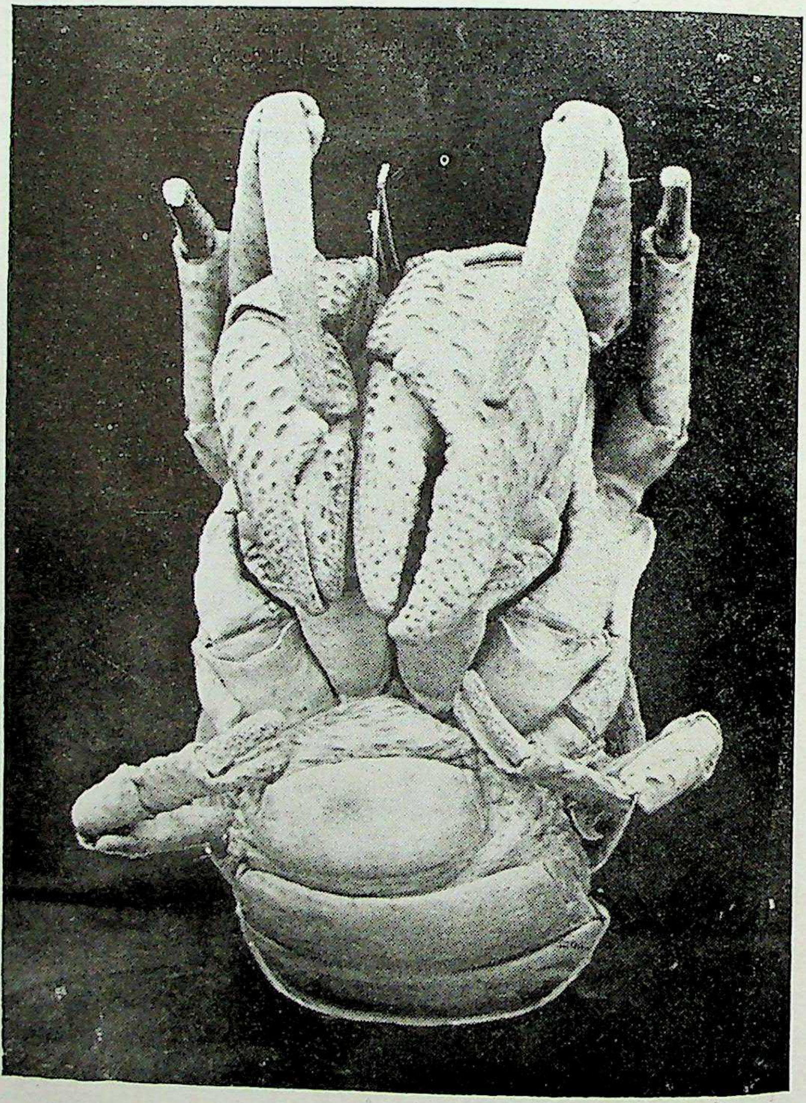

FIG. 41—BIRGUS LATRO: THE COCONUT CRAB OR ROBBER CRAB: (VENTRAL VIEW).

Suborder BRACHYURA.

This group includes the true crabs and comprises a very large number of species, Specimens (both dry and wet-preserved) belonging to most of the common South Indian species are exhibited. They belong to different families and it would therefore be most convenient to describe them in the present handbook grouped under their respective families.

Crabs are characterized by the abdomen being reduced and tucked underneath the enlarged front part of the body which is protected by a broad shield-like plate, the carapace. As the abdomen acts as a protective flap for the eggs as these develop into embryos, it is usually much broader in the female than in the male.

Crabs exhibit an extraordinary variety of shapes and colours. Some live on land and some in freshwater, but the majority of the species are marine. The aquatic forms are specially adapted for swimming, the terminal segments of the last pair of thoracic legs being oar-shaped in such forms. Some crabs are found in regular association with other animals, exhibiting various degrees of commensalism, leading on to parasitism.

The life history of crabs is very similar to that of lobsters, but in crabs, a *Megalopa* larval stage usually intervenes between the Zoea and the adult forms. The *Magalopa* has a large abdomen, and its appendages are much the same as in the adult.

The species of crabs represented in this gallery are almost exclusively marine and belong mostly to the families Calappidae, Portunidae, Leucosiidae, Xanthidae, Graspidae Ocypodidae, Maiidae and Dorippidae.

Family Calappidae.—The family includes the Box crabs, in which the front limbs are broad, somewhat flattened and crested and when at rest, they are closely apposed to the front of the carapace so that the crab superfically resembles a compact rectangular box in this position. Specimens of the typical species, *Calappa hepatica* from Krusadai Island and *Matuta victor* from Ennur are exhibited. The latter is bright yellowish in colour and is very abundant in backwaters, often remaining buried in sand for long periods.

Family Portundae.—This is a large family, well represented in Indian waters. It includes the two-oared swimming crabs, recognized by the broadended and flattened form of the feet of the last pair of legs only, the preceding three pairs being normal, pointed walking legs. This family comprises a large number of quite familiar species of brightly coloured and ornate crabs, many of them being edible. *Scylla serrata* (Fig. 42) is the large edible swimming crab with powerful claws common in the backwaters. In *Neptunus* the carapace bears a pair of very strong lateral spines which project outwards, one on each side. Two species of *Neptunus*, namely, *Neptunus pelagicus* (Fig. 43) and *N. sanguinolentus* are common in the backwaters at Ennur and specimens of

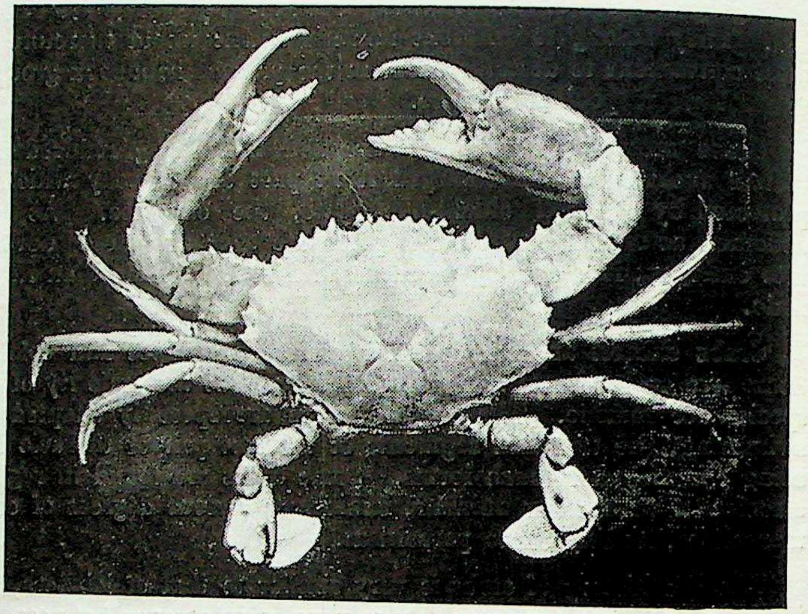

FIG. 42—SCYLLA SERRATA: A MARINE EDIBLE CRAB.

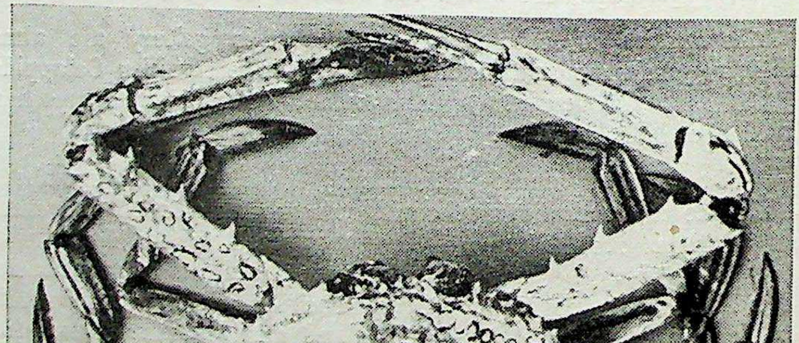

FIG. 43—NEPTUNUS PELAGICUS; ANOTHER SPECIES OF MARINE EDIBLE CRAB.

both these are exhibited. These are also edible. In the former specties, the shell bears reticulate markings while in the latter there are three large, bright red, widely spaced rounded spots near the hind margin of the carapace. *Charybais curcifera* in which the shell bears a large, cross-shaped mark, is represented by a large specimen from Ennur. In Krusadai Island and Pamban in the Gulf of Manaar, two species of *Thalamita*, namely, *Thalamita prymna* and *T. crenata* are often found in large numbers and several specimens of both these species, most of them preserved as dry mounts in glass-topped exhibition boxes are displayed. In *Thalamita*, the front of the shell is more or less rectangular, with the eyes widely separated and placed more or less at its extreme lateral angles.

Family Leucosiidae.—This family includes small, whitish crabs with very hard, made or less globular shells and with relatively long and slender claws. They are mostly burrowing in habit. A specimen of *Philyra globosa*, common on the sandy beach at Madras is exhibited.

Family Xanthidae.—This family is much more abundantly represented at Krusadai than at Madras and several large forms belonging to a number of different genera have been collected from the reefs at Pamban and in and around Krusadai Island. This family includes species mostly with very robustly built carapace, the front margin of which is broadly and evenly curved. The surface of the carapace bears distinct grooves in most species. Several species are very brightly coloured. Among others, the exhibited specimens of this family include several large ones of the species *Eriphia laevimana Etsius leavimanus and Aetergatis intergerrimus* all of which are common on Krusadai Island, especially among the stones and shingle on the coral reefs.

Family Ocypodidae.—The Ocypodidae include crabs mostly with squarish or rectangular box-like carapace with eyes widely set on long, slendar stalks and usually inhabit the sandy beaches where they run about swiftly on the surface and also burrow rapidly in the sand. In most species the carapace is brightly coloured, but some are sand-coloured and inconspicuous in their normal habitat. Dry preserved specimens of *Ocypoda platytarisis* and *O. macrocera* which are particularly common on the sandy beaches at Krusadai and wet- prescribed male and female specimens of the remarkable Dhoby crab or Fiddler crab, *Gelasimus annulipes* (Fig. 44) are exhibited as representatives of this family.

In the Dhoby crab (or Calling crab as it is sometimes called), one of the front claw-bearing limbs in the male is disproportionately enlarged and brightly coloured red. It derives its popular name from the fact that the male has the habit of sitting at the mouth of its burrow and waving its immense, bright red, claw-bearing front limb much in the same way as a dhoby beating clothes on a stone or as if beckoning some one towards it; hence the popular names Dhoby crab or Calling crab. These crabs usually frequent marshy areas or the muddy banks of backwaters, and are often gregarious, a large number of them being found together. At the slightest sign of approaching danger the several bright red limbs disappear as if by magic as the crabs hastily retreat into their burrows in the sand.

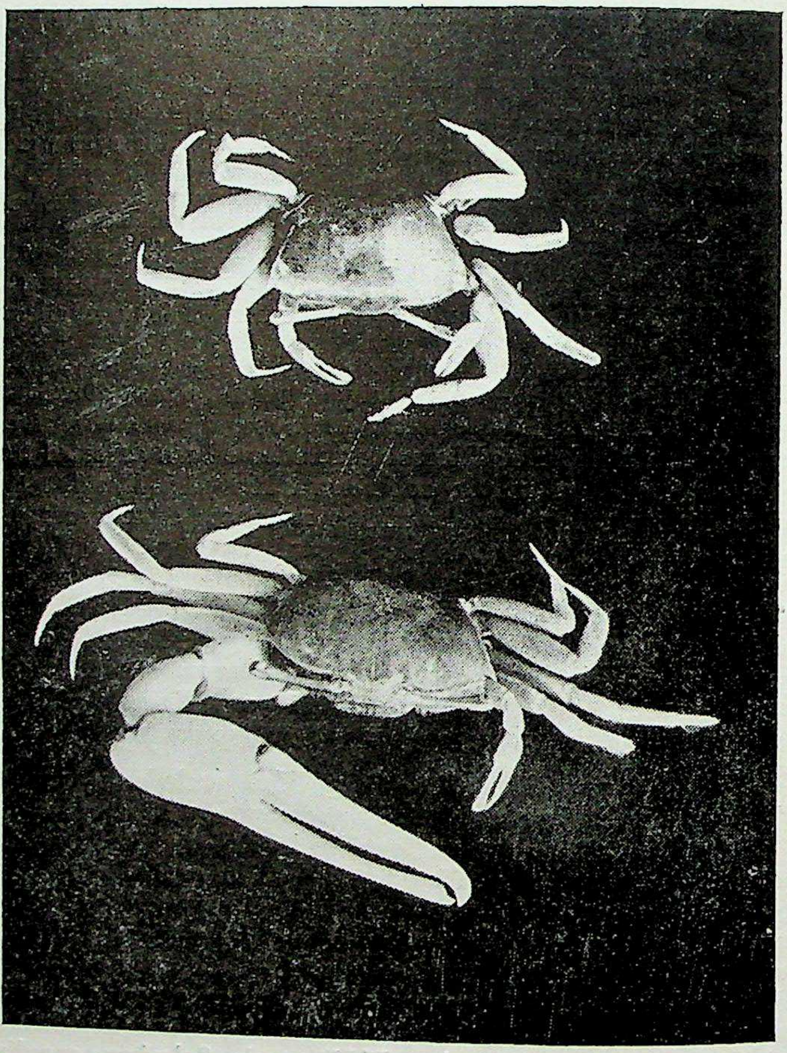

FIG. 44—GELASIMUS ANNULIPES: THE DHOBY CRAB OR CALLING CRAB OR FIDDLER CRAB MALE, ABOVE: FEMALE, BELOW; (NOTE THE ENORMOUS CLAW-BEARING FRONT LIMB OF THE MALE).

Family Graspidae.—This family comprises mostly flattened crabs, with the carapace either narrowed in front and rounded in shape or very broad in front and more or less quadrangular in shape. As an example of this family, a dry-preserved specimen of *Graspus strigosus* is exhibited. It is a flattened marine crab with a characteristic dark greenish carapace with dark striations. It is common among the concrete blocks in the Madras Harbour, and is also the largest and most familiar species of this family found on the reefs at Krusadai and around Pamban.

Family Maiidae.—A specimen of the common spider crab *Doclea ovis*, from Ennur, with its characteristic rounded shell and relatively long, slender, walking legs, is exhibited as the sole representative of this family.

Family Dorippidae.—Crabs of this family are sometimes called the Masked crabs on account of their habit of holding as a mask against their backs some extraneous objects as a protective device, the last two pairs of legs being modified for this purpose. A wet-preserved specimen of *Dorippe facchino* which is the commonest species found at Madras, is exhibited. It is a rather small flattened, mud-coloured crab usually bearing on its back a piece of bivalve shell to which a sea anemone is attached.

ECONOMIC IMPORTANCE OF CRUSTACEA.

Many species of Crustoceans, especially crabs, lobsters, prawns and shrimps are highly esteemed as human food and form the basis of a valuable commercial fishery in many parts of the world. Shrimps are captured with seines, while lobsters, crabs and cray-fishes are captured by means of special baited traps known as lobster pots or crab pots. Lobsters are considered as a delicacy in Europe and America. Many species of small Crustaceans found in salt and freshwaters are important links in the food cycle of many fishes and other aquatic animals. But some species of Crustaceans are harmful. Some Copepods, for instance, *Cyclops*, act as intermediate hosts for parasitic worms infesting man and some crayfishes often damage valuable fields of commercial crops such as cotton and corn.

Class INSECTA=HEXAPODA:)

Insects constitute a very large and important Class of arthropods, in which the body is divided into a head, thorax and abdomen. In the adult state there are three pairs of legs and usually two pairs of wings, borne on the thorax. Respiration is by means of minute branched tubes known as tracheae. The head bears one pair of feelers (antennae), one pair of mandibles or jaws and two pairs of maxillae, the second pair being fused medially. The mouth parts vary in structure in different insects, being adapted to different types of feeding habits, such as chewing, sucking or lapping. The abdomen is devoid of any walking appendages. The young are almost always quite different from the adults and usually the larvae undergo either an incomplete or complete metamorphosis before assuming the adult form.

Insects include a vast number of widely differing creatures such as grasshoppers, flies, lice, butterflies, moths, beetles, bees and a host of other similar forms. They are the most abundant and most widely distributed of all land animals. They are the only invertebrates that are capable of flight and they abound in all types of habitats, except the sea. Various species live in fresh and brackish waters, in soil, on or among plants of all kinds and also parasitic on or inside the bodies of other animals. Insects also vary enormously in size ranging from 1/50th of an inch to over six inches in length.

Economically, insects are the most important group of animals, next to the mammals, brids and fishes. Their activities affect man either from the nature and extent of the harm they do to various crop plants or to animals or to stored products, or from their value in yielding products beneficial to man. They are also important from the point of view of the part they play in the economy of nature, in the pollination of flowers, in acting as scavengers, in preserving the condition of the soil and in providing food for various species of birds and fishes.

The greater part of the insect collections of this Museum are preserved and stored as reference and study collections in cabinets and arranged in their systematic order. These are not displayed to the general public, but are always available for study and examination by students, research workers and others interested.

In the Insect Section of the Invertebrate Gallery, however, only a few selected specimens are mounted and exhibited mostly as dry mounts, to represent the more important among the numerous Orders of Insects, and the economic aspects of insects are illustrated by a series of labelled crop pests and a collection of useful products yielded by insects such as silk, lac, etc., besides, a small collection of the various types of insect nests and their photographs, and numerous coloured illustrations depicting the life histories of insects are also exhibited.

As an introduction to the exhibited series of insects, a few clear, enlarged, labelled diagrams showing the external and internal anatomy of a typical insect are exhibited to illustrate the salient features of the structure of an insect, at the commencement of the systematic display of the various specimens representing the Insect Orders.

Besides these, an Introductory series of informative exhibition cases are also displayed in an adjoining vertical show case along the wall, illustrating some specific themes pertaining to the biology of insects, namely, their classification into their various principal

Orders, sexual dimorphism in insects (i.e., instances where the male and female of the same species are quite different), the modifications in the wing characters in different groups of insects, exmaples of aquatic insects, and a two-dimensional representation of an evolutionary tree of Insects showing the sequence and systematic position of the various principal Insect Orders in the process of Evolution. These exhibits serve to introduce the visitor to the interesting diversity of form, structure and habits met with in this vast and heterogeneous group of arthopods, and thus facilitate a better understanding of the relationships between the various principal groups of insects.

EXHIBITION UNITS IN THE INTRODUCTORY SERIES.

I. *Classification of Insects.*—Insect classification is a very complex subject which is constantly undergoing numerous changes in the light of recent researches. Till recently, 26 Orders of insects were recognised, but in the latest edition of Imm's Genral Text-book of Entomology, 29 Orders are mentioned and other authors recognize even a larger number of Orders. For the purposes of this Guide book, however, it would be sufficient to refer only to the more important and familiar Orders which are acutally represented in this gallery by exihibited specimens.

The Insects are broadly divided into two main Sub-classes, namely, Apterygota, including the primitive, wingless insects such as the Bristletails and Springtails, and the Pterygota, comprising the winged insects. consisting of all the rest of the Insect Orders, which are more advanced in structure than the wingless insects. In the present Introductory panel, a few typical representative specimens of only eight of the major Orders of the winged insects (Pterygota) comprising most of the more common and familiar forms of insects (with brief labels indicating the salient features of these important Orders) are exhibited to give the visitor a broad, general idea of the more typical forms of insect life.

A more detailed and comprehensive display of selected specimens of South Indian Insect fauna representing most of the major Orders of insects are exhibited in the series of central show cases that follow, occasionally supplemented by enlarged models and diagrams, and accompanied by brief descriptive labels explaining the chief distinguishing features of these Orders. Twenty-two out of the twenty-six Orders of insects are thus represented among the exhibits, either by actual specimens or illustrative diagrams and models.

II. *Sexual dimorphism in Insects.*—The sexes are always separate in insects, but it is normally difficult to distinguish between the two sexes from their external appearance alone. In some forms, however, there are some easily recognizable external secondary sexual features such as colour, size, differentiation in external structures, etc., by means of which they can be distinguished. Six species of such insects, where the sex differences are quite prominently marked, are exhibited. In the butterflies and the dragnoflies in the top row there are marked differences in the colour of the wings, while in beetles and the Carpenter bee below, there is differentiation in external structures such as the rostrum, mandibles and antennae.

III. *Wing Characters of Insects.*—Insects are the only creatures which possess wings among the lower animals (Invertebrates). Wings are found only in the adult, and even among the adults, there are some primitive forms such as the Silver-fish (*Lepisma*) which are wingless. The nature of the wings differs in the various Orders. In the dragonflies, both are transparent and membranous. In beetles, the front pair are modified into hardened plates called " elytra ", while the hind pair are membranous. Among the bugs, the front pair are either partly membranous and partly horny (Heteroptera e.g., *Belostoma*, the Giant Water Bug), or uniformly horny throughout (Homoptera, e.g., Cicada) In the flies (Diptera), the hind pair are modified into knobbed structures known as halters. In butterflies and moths, they are clothed with scales, and in many moths, the fore and hind wings are held together by an apparatus called " frenulum ". In Hymenoptera (wasps and bees), the fore and hind wings are held together by a row of hooks.

IV. *Aquatic insects.*—Many species of insects are aquatic and some of the best known South Indian examples of aquatic insects are exhibited. Adaptations to an aquatic life have arisen independently in the most diverse Orders of insects. The main adaptive features affect the form, relations with the surface film, methods of feeding and locomotion and respiration. The highly polished, smooth, elliptical contour of most of these insects serves to reduce the resistance to the water while swimming. In many aquatic insects the third pair of legs, or the second and third pairs are specially modified for swimming by being flattened and fringed with hair. Adaptations to an aquatic life are most frequently met with among bugs and beetles, but the larvae of several other groups of insects are aquatic.

V. " *Evolutionary Tree* " *of insects.*—The imaginary tree illustrated in this exhibit indicates the general relationships of the chief Orders of the Class Insecta and their evolutionary sequence. Lowest in the scale of evolution are the primitive insects, such as the wingless fish insects and springtails, while the most highly organized insects such as the beetles, bees, wasps and butterflies are placed at the top to indicate their advanced grade of organization. In general, the classification of insects may be said to be based mainly on the presence or absence of wings, the structure of the mouth parts and the character of the life history.

SYSTEMATIC SERIES OF TYPICAL SOUTH INDIAN INSECTS.

Subclass I—APTERYGOTA.

The Apterygota include minute or small, primitive, wingless insects with little or no metamorphosis. The abdomen bears small ventral appendages.

All the four Orders of Apterygota are represented in this gallery mostly by diagrams, at the commencement of the systematic series of insects.

Order THYSANURA.

(*Bristletails.*)

This Order includes the most primitive of all insects and is widely distributed. Some are minute, but others may range in size up to 30 millimeters. They have chewing mouth parts and their antennae are long. The body is scaly. This group includes the familiar "Silverfish" (*Lepisma saccharina*) which is common in buildings on the walls in many parts of the world and eats starch in books, glazed paper, clothing, etc. A wet-preserved specimen of the common Silverfish is exhibited.

Order DIPLURA.

(*Japygids.*)

These insects were formerly united with the Thysanura in a single Order. Like the Bristletails, the Diplura are a group of primitive insects, widely distributed. They live concealed under stones or dead logs of wood or among fallen leaves in the soil. Their feelers (antennae) are long, but they have no eyes. They have chewing mout hparts. *Letidocampa* and *Campodea* are two typical genera. Illustrations of *Lepidocampa* are exhibited to represent this Order.

Order PROTURA (=MYRIENTOMATA).

These are minute, primitive insects ranging in size from 0.6 to about 2 millimetres. They are whitish, elongated insects, without antennae, true eyes or wings. They are widely distributed and found mostly in moist soil, peat and in the humus in deciduous woodland, but owing to their minute size they are rarely recognized in their natural haunts. As the antennae are absent, the front legs are held upwards in front of the head while walking and probably serve as tactile organs. An enlarged diagram (dorsal and ventral view) of *Acerentomum doderoi* is exhibited to represent this Order.

Order COLLEMBOLA.

(*Springtails.*)

The Collembola, or Springtails, are small or minute insects, rarely exceeding a length of 5 mm. and occur almost in all situations. They may coloured or white. Compound eyes are present and the mouth parts are of the chewing type. They are found in the soil, in decaying vegetable matter, or under barks of trees, etc. A few species are found in the nests of ants and termites. Some species are freshwater and a few are littoral or marine. They vary very much in their colouration. Some are a uniform dull bluish black, while others are green or yellowish, with irregular darker markings. On account of the minute size of these insects, only an enlarged diagram of a typical species is exhibited.

Subclass II—PTERYGOTA.

The Pterygota includes the winged insects, comprising by far the great majority of insect species. Wings are usually present, but sometimes they are secondarily reduced or absent. The metamorphosis is varied.

This subclass is divided into two main divisions, namely, (1) the Exopterygota (=Hemimetabola) in which the metamorphosis is slight or simple and the wings develop externally and (2) the Endopterygota (=Holometabola) in which the metamorphosis is complex and complete and the wings develop internally.

The chief distinguishing features of those Orders which are represented by exhibited specimens in this gallerv are briefly outlined below. These Orders are grouped under their respective divisions and are arranged below in their proper systematic sequence, i.e., in the same order in which these groups are exhibited in this gallery. A few selected and typical representative specimens of each of these Orders, mostly belonging to common South Indian species, are exhibited.

DIVISION I—EXOPTERYGOTA (=HEMIMETABOLA).

Order EPHEMEROPTERA.

(*Mayflies.*)

These are slender, fragile insects, with poorly developed mouth parts and small, short and antennae. The first pair of wings are much larger than the second; sometimes the hind pair are wanting. At the apex of the abdomen are two or three slender, elongated processes. The eggs laid in the water sink and take about six months to hatch out. The larvae are aquatic and are provided with plate-like gills for breathing and feed on mud or minute aquatic vegetation. The nymphs pass through a sub-imago-stage before they emerge as the adults. Mayflies are perhaps the shortest-lived insects known, the adults living only for a few hours or days at the most.

Order ODONATA.

(*Dragonflies.*)

These are large, elongated insects, often with a brightly coloured body and chewing mouth parts. The head is very mobile, with very large, prominent eyes and short antennae, ending in a bristle. There are two pairs of long, narrow, transparent, membranous wings which are reticulated with complex cross veins. Both the fore and hind wings are similar in texture, and are held out horizontally in repose. The wings are placed behind the level of the legs. The abdomen is elongated with rigid, unjointed, tail processes. The adults possess very strong powers of flight and are predaceous in their habits. The larvae are aquatic, with varying adaptations for breathing dissolved oxygen in the water.

Order PLECOPTERA.

(*Stone flies.*)

This Order includes moderate-sized or large-sized insects with four membranous, reticulate wings. The hind wings, are large, and have an anal fan, with simple venation, which becomes plicate, when folded. The legs are widely separated. The antennae are long and there are usually four long anal cerci. The larvae are aquatic and the metamorphosis is slight. These larvae live under stones and feed on small insects. They are sometimes used as fish bait. The flight of the adults is weak.

Order ORTHOPTERA.

(*Grasshoppers, Crickets, etc.*)

This Order includes cockroaches, grasshoppers, locusts, crickets, mantids, stick insects, leaf insects, etc. In recent systems of classification, however, the stick and leaf insects have been separated into a distinct Order, Phasmida. he Orthoptera are medium to large-sized insects, with conspicuous biting and chewing mouth parts. The lower lip is longitudinally divided in the median line. The first pair of wings are thickened, coloured or ornamented and narrow, while the second pair are large, membranous and often coloured faintly and folded below the first pair in repose. The forelegs are adapted for running or capturing the prey, and the hind legs for running or leaping. Anal cerci are usually present and jointed in appearance. The female has no ovipositor (egg-lying apparatus). The metamorphosis is imperfect. None are aquatic, social or parasitic.

Representative South Indian specimens of the families Blattidae (cockroaches), Mantidae (Praying mantis), Phasmidae (stick insects), Acrididae (grasshoppers) (Fig. 45), Tettigonidae (long-horned grasshoppers) and Gryllidae (crickets) are exhibited. Of these, the painted locust, *Poecilocerus pictus*, the extraordinary, grotesquely shaped and robustly built locust, *Schizodactylus monstrosus*, and the mole cricket, *Gryllotalpa africana* are particularly noteworthy. In the mole cricket, which burrows underground, the thigh and shank of the foreleg are flattened from the sides forming a deep and powerful organ and this is continued in the foot. The broad edge of the shank ends in four hard, finger-like points which make an efficient digging instrument. An enlarged diagram of the foreleg of the mole cricket is exhibited to illustrate these peculiar features. Stick insects (Figs. 46 and 47) and leaf insects are remarkable for their striking protective resemblance to their surroundings. Many species of locusts are migratory and cause immense damage to cultivation.

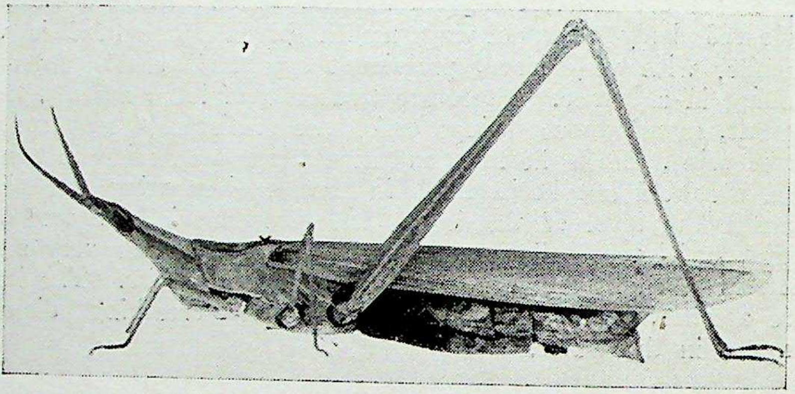

FIG. 45—ACRIDIDAE: THE GRASSHOPPER.

Order DERMAPTERA.

(*Earwigs.*)

These are slender, elongated insects, with the segments arranged imbricately (i.e., in an overlapping fashion) and with the body terminating in a pair of forceps-like processes. The forewings are short and the hind wings large and radially folded. Wingless forms are very numerous. The young is very similar to the adult.

Order EMBIOPTERA.

(*Web spinners.*)

These are elongate, delicate insects, with a small pro-thorax and elongate meso- and meta-throax. Wings may or may not be present. The females are all wingless, but the males are usually winged. When present, they are delicate and membranous with few veins and pigment bands. The mouth parts are adapted for biting. They are usually found on the surface of the ground and

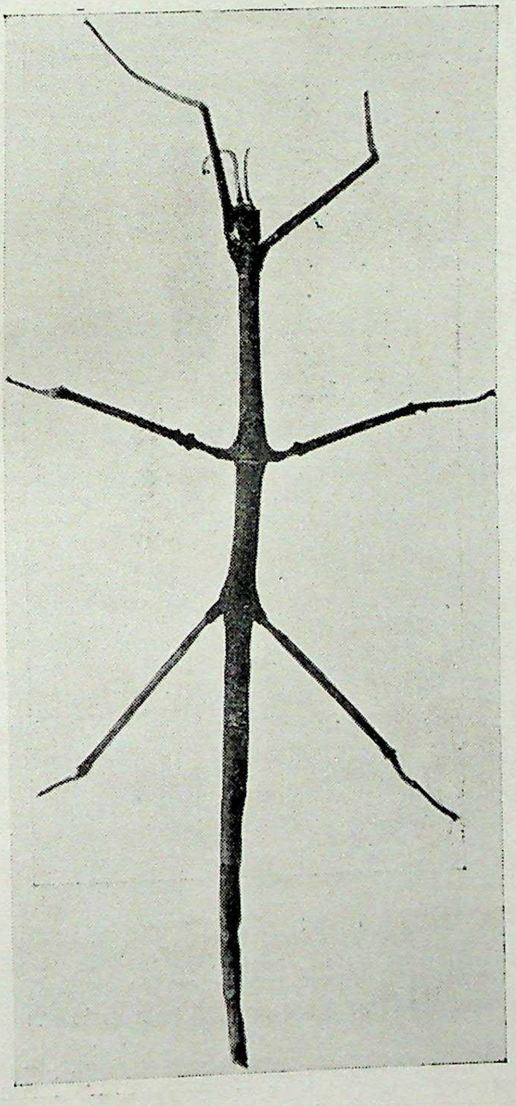

FIG. 46—LONCHODES SP.: THE STICK INSECT (DORSAL VIEW).

under stones, and they construct webs from threads produced by glands in the forefeet. They feed on decayed vegetable matter. Their development is incompletely known, and they do not form organized societies.

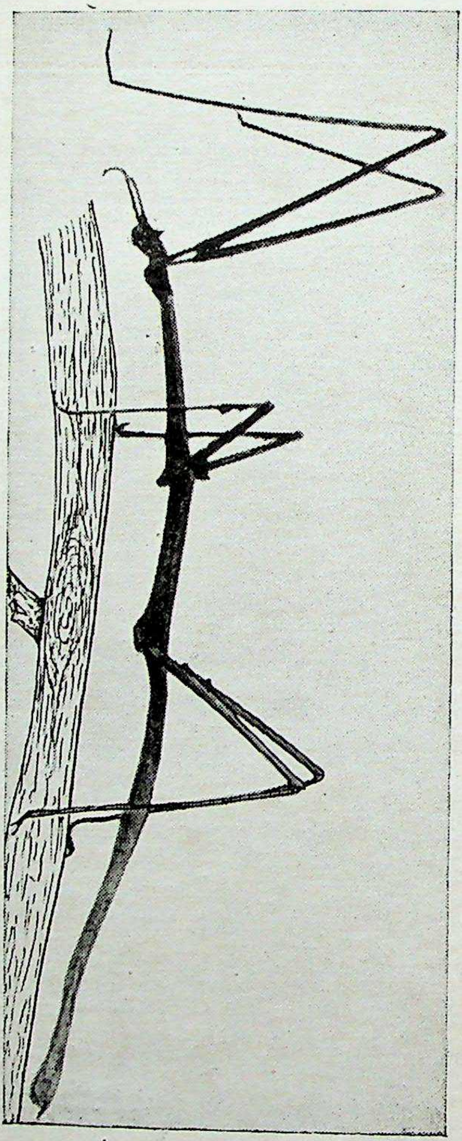

FIG. 47—LONCHODES SP.: THE STICK INSECT (SIDE VIEW)

Order ISOPTERA.

(*Termites or " White ants ".*)

This Order includes social insects consisting of winged and wingless individuals. The former have four large wings lying flat on the back when in repose, membranous and greatly elongate, reaching far beyond the tip of the abdomen. Near the base of each wing is a line along which the wing can be easily broken off. The latter (i.e., the wingless individuals) have the head and thirteen distinct body segments. There is a pair of anal processes (cerci). The antennae are short and straight. The legs are adapted for running and the mouth for biting. The metamorphosis is slight and gradual.

Termites exhibit a remarkably high grade of social organization. They live in colonies in elaborate, ramifying underground nests known as termitaria. A termite colony usually consists of a royal pair—a king and queen—which are fertile, sterile castes usually consisting of soldiers and workers which are wingless males, and females adapted for special non-reproductive functions. Besides, a large number of winged males and females are produced

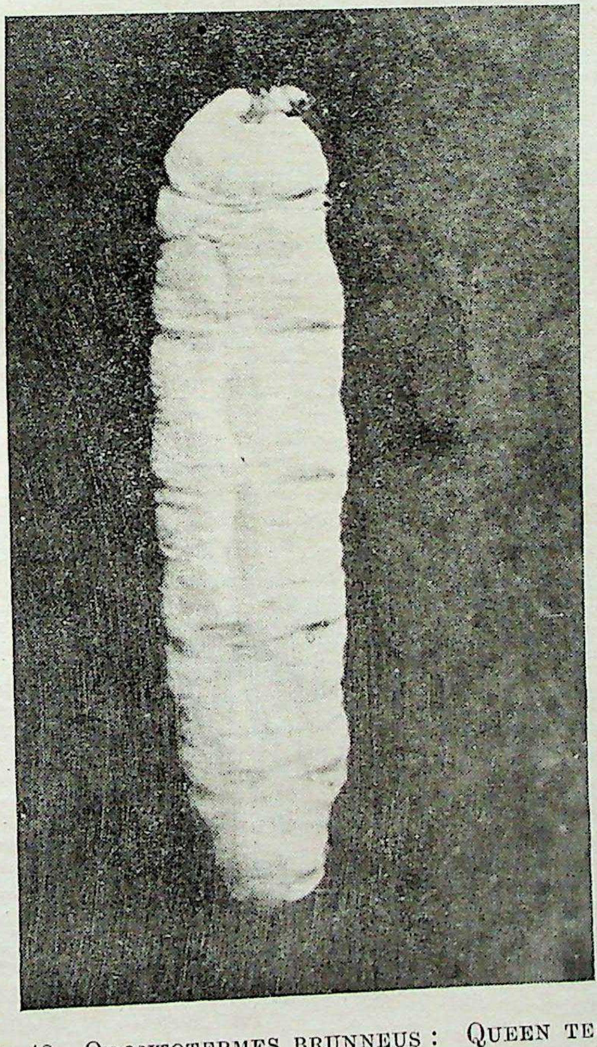

FIG. 48—ODONTOTERMES BRUNNEUS: QUEEN TERMITE.

at particular seasons of the year to form new colonies. The queen is an enormous grub-like creature, living in the nest, whose sole function is the production of eggs. A large specimen of the queen of the species *Odontotermes brunneus*, (Fig. 48) a common South Indian forms, is exhibited along with the other types of winged and wingless individuals of the colony.

Termites are extremely destructive and often cause incalculable damage to wooden rafters, doors, window-frames, furniture and even books and clothing. Very effective methods of control are necessary to prevent the ravages of white-ants.

Order ANOPLURA (=SIPHUNCULATA).

(*Lice.*)

These are wingless, laterally flattened, parasitic, blood-sucking insects. The head bears in front a short tube provided with hooks from which tube there arises another very delicate protrusible sucking tube. The three thoracic segments are fused into one mass. They live in the hair of mammals, and their feet which are provided with very strong claws, are adapted for clinging to the hosts' hair. Two species infest man, and about a dozen occur on domestic animals. The best known species is *Pediculus humanus*, the common louse of man.

Order HEMIPTERA (=RHYNCHOTA).

(*Cicadas, Bed bugs, Plant bugs, etc.*).

Bugs are easily distinguished by the nature of their mouth parts which are invariably of the piercing and sucking tyre. The most characteristic feature of these insects is the modification of the lower lip into a tubular sheath, which includes the mandibles and maxllae which are used as piercing organs. This is kept bent backwards under the thorax. They have normally two pairs of wings, of which the anterior pair are most often of a harder consistency than the posterior, and are either uniformly so (as in the group Homoptera) or half horny and half membranous (as in the group Heteroptera). The female has often a well developed ovipositor. The metamorphosis is simple. This Order includes insects which feed on the sap of plants (plant bugs) or the blood of vertebrates and insects (bed bugs, etc.).

Selected specimens of some of the more common species such as Cicadas, plant bugs and aquatic bugs including the Giant Water Bug (*Belostoma indica*) (Fig. 49) are exhibited. Cicadas are the largest of the Homoptera and are the longest lived insects, some American species being known to live even for seventeen years. The male Cicadas produce an extremely shrill, almost deafening noise, but the females are voiceless. A large number of species such as the Red Cotton Bug, Aphids, etc., live on plant juices. This Order also includes the lac insect, *Laccifer lacca,* which produces the lac of commerce. A coloured illustration showing the lac insect and various stages in its life history is exhibited. An entire case full of various types of lac products is also exhibited among the Economic Products derived from insects, in this gallery.

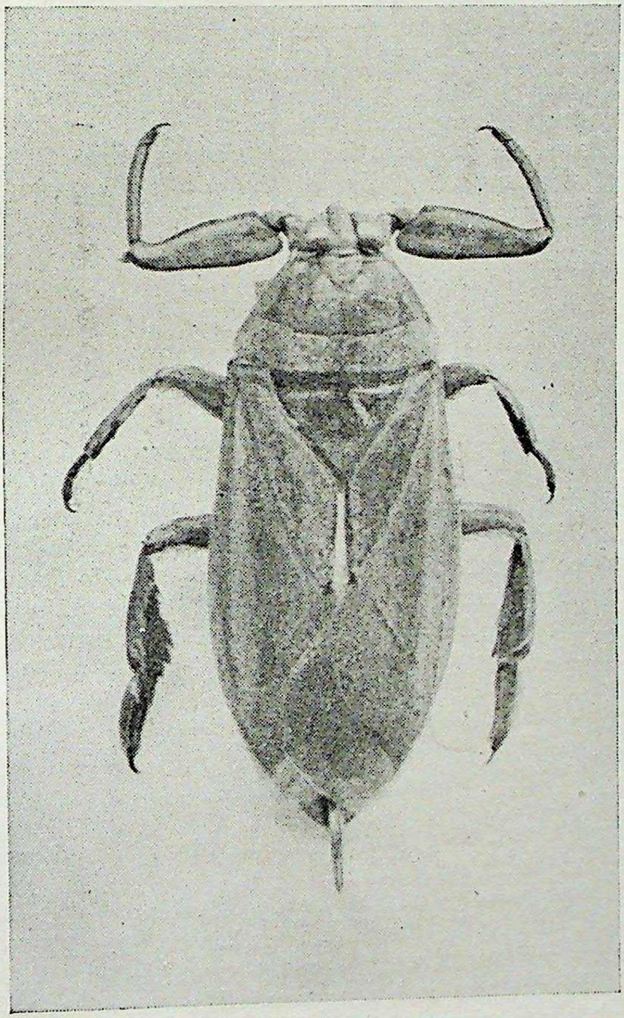

FIG. 49—BELOSTOMA INDICUM: THE GIANT WATER BUG.

Order THYSANOPTERA.

(*Thrips.*)

This Order includes very small insects which have a short head, short feelers and jaws adapted for piercing and sucking, the mandibles being slender and needle-like. When both pairs of wings are present, they are slender and membranous, and fringed with long hairs, on one or both margins, or the wings may be represented only by rudiments, or there may be no wings at all. The thorax and abdomen are slender, the latter tapering to the apex. The legs are adapted for running. The young resemble the adult in general form. Thrips are mostly yellow, yellowish brown or black in colour and are found among all types of vegetation. Both larvae and adults scrape the thin epidermal layers of flowers, leaves and fruits and suck out the juices of plants, leaving white scars. Many species are injurious to crops and some are predaceous, sucking the body fluids of mites and other small insects. Some are known to transmit virus diseases of plants. On account of the very small size of the actual specimens, only an enlarged diagram of a typical species is exhibited.

DIVISION II—ENDOPTERYGOTA (= HOLOMETABOLA).

Order NEUROPTERA.

(*Lacewings, etc.*).

This Order includes lacewings, ant-lion flies, elder flies, snake flies, etc. They have biting and chewing mouth parts, and two pairs of large, membranous, net-veined wings, ordinarily similar in form, which are kept roofed over the abdomen when at rest. Anal ceri are absent. The larvae are spindle-shaped, with grooved suctorial mandibles and are predaceous. The metamorphosis is complete. A single, wet preserved specimen of a lacewing is exhibited.

Order MECOPTERA.

(*Scorpion flies*).

The members of this Order are small to large-sized insects with long legs and antennae. The head is prolonged in front into a downwardly projecting beak at the tip of which is the mouth with its elongated and spear-like mandibles for biting. The wings are long, narrow and membranous, many-winged, and both pairs are closely similar in form and neuration. The wings are kept roofed over the abdomen when at rest. The anal cerci are short and the female has an elongated ovipositor. Some males carry the end of the abdomen curved upwards like a scorpion (hence the name scorpion flies). These insects inhabit dense herbage and are carnivorous. The larvae are caterpillar-like, having eight pairs of abdominal prolegs and three pairs of thoracic legs, and live in burrows, feeding on the ground surface.

Order LEPIDOPTERA.

(*Butterflies and Moths.*)

This large and well known Order includes moths and butterflies. These insects do not posses mandibles. The maxilae are modified to form an elongated, grooved and flexible sucking tube. An enlarged diagram showing the sucking tube of the butterfly is exhibited. The body and wings are covered with flattened scales. The colouration, which is mainly due to the scales, may be brilliant or dull and obscure. All of them undergo a complete metamorphosis. The larvae are typical caterpillars which have a soft, tuberculated or spiny body. The pupa of moths and butterflies, which is generally known as the "chrysalis" differs from that of other insects in that its outer skin forms a hard coat. Many pupae are protected by cocoons which are masses of silk disposed by the caterpillars around themselves during the final stage of their existence.

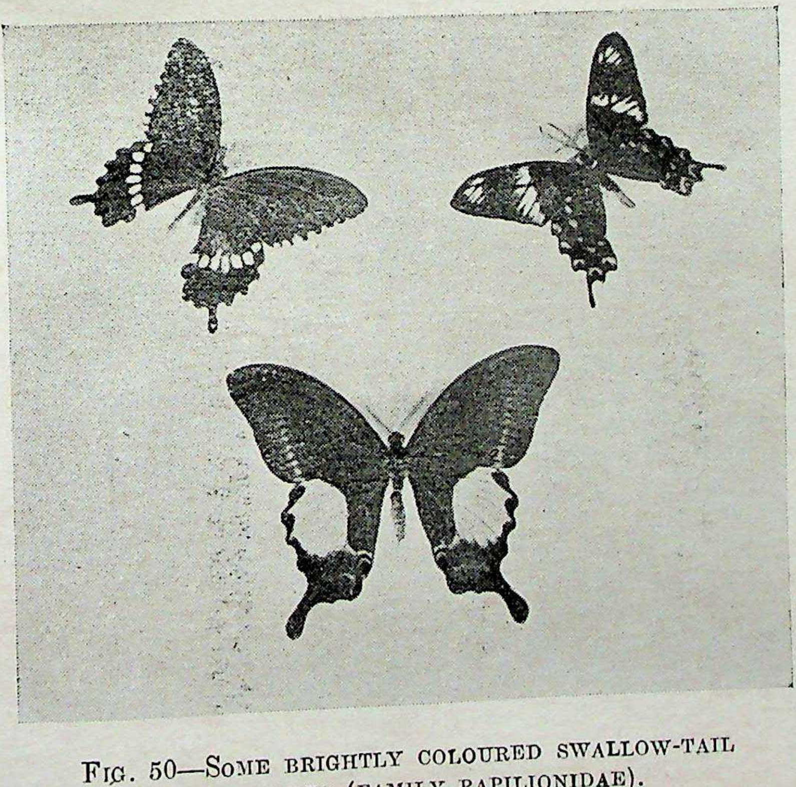

FIG. 50—SOME BRIGHTLY COLOURED SWALLOW-TAIL BUTTERFLIES (FAMILY PAPILIONIDAE).

The Lepidoptera include an enormous number of species and are the most familiar and easily recognizable of all insects. It is in this Order that colouration reaches its maximum development among insects. Economically, too, the Lepidoptera are of great importance, the larvae of many species being injurious to plants. On the other hand, the silk moth is extremely valuable commercially, being the basis of the silk industry.

Several brightly coloured species of butterflies and moths belonging to common South Indian species, including the beautiful Swallow tail butterflies (Fig. 50) (family Papilionidae which includes some of the finest of Indian butterflies known as the Blue Peacocks and Banded Peacocks, and the very large Atlas Moth (*Attacus atlas*) (Fig. 51) and the pale green Moon Moth (*Actias selene*) (Fig. 52) are exhibited. Some species of South Indian butterflies afford interesting examples of mimicry.

An enlarged diagram, illustrating the sucking tube of the butterfly is also exhibited beside the specimens. The butterfly feeds by sucking nectar from flowers. For this purpose, its mouth parts are modified—the maxillae being elongated and grooved forming a tube when their edges interlock. This tube lies coiled

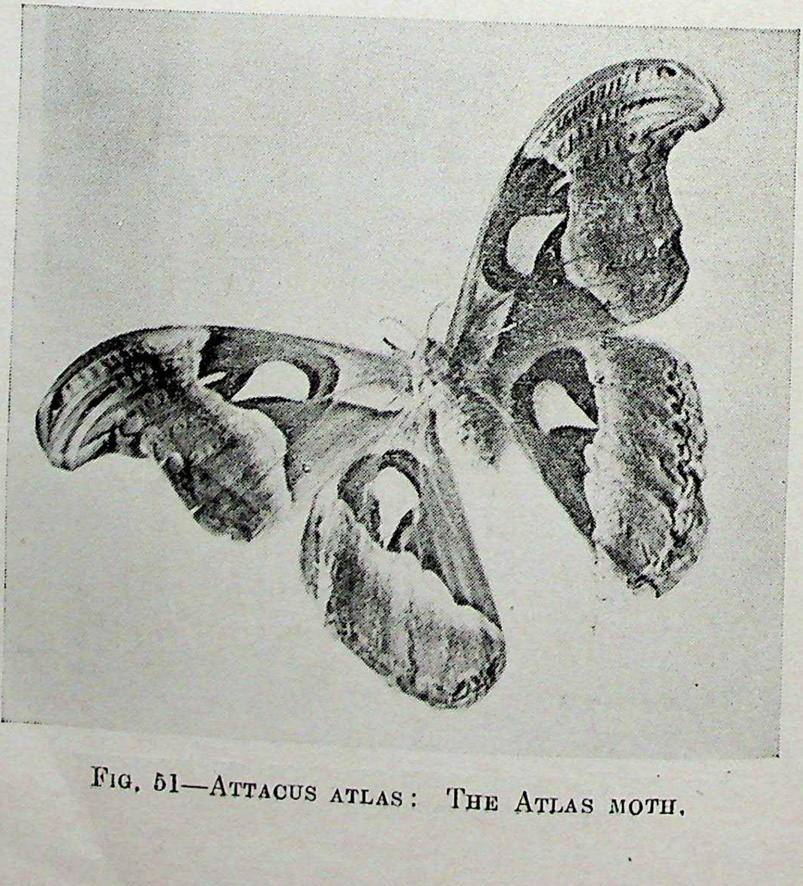

FIG. 51—ATTACUS ATLAS: THE ATLAS MOTH.

under the head like a watch spring. When the butterfly visits flowers, the tube is unrolled and inserted into the nectar and the sweet juice is sucked through it. The two interlocking halves of the tube are seen partially separated in the diagram.

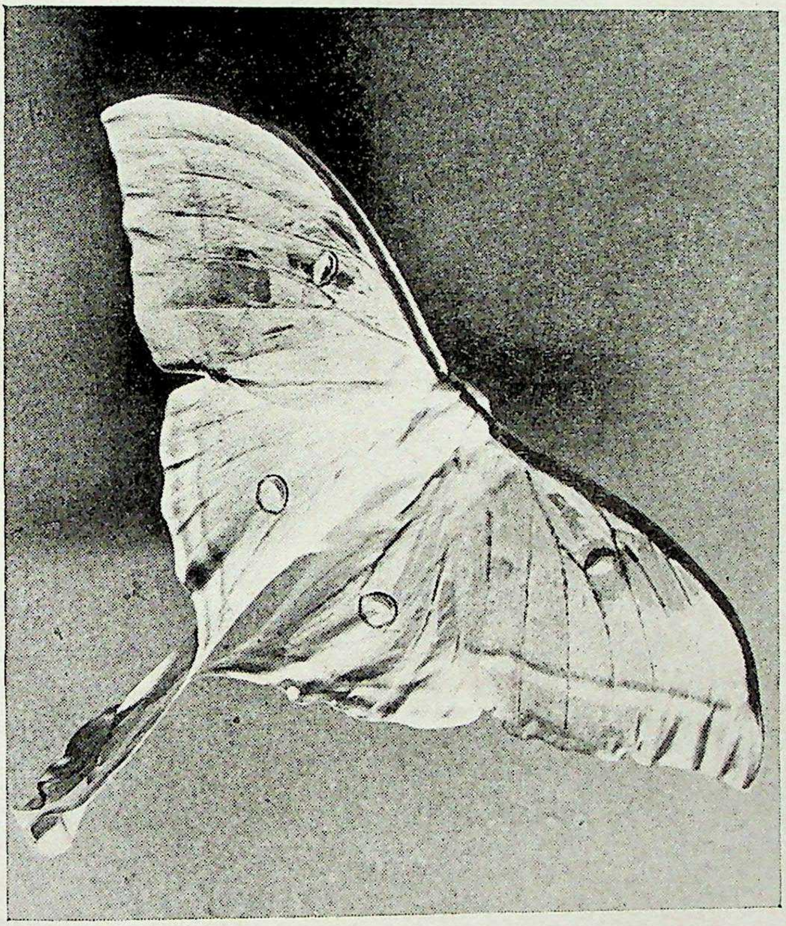

FIG. 52—ACTIAS SELENE: THE MOON MOTH.

Order TRICHOPTERA.

(*Caddis flies*).

These are rather delicate insects, rather moth-like in appearance, but with the wings placed over the abdomen when at rest. They have very long antennae and no mandibles. The larvae are caterpillar-like and carnivorous, living in freshwater and usually making cases of a great variety of materials such as silk, vegetable matter, stones, shells, gravel, etc. The pupa is like an immature imago and active just before the last moult. Some larvae, in rapidly moving water, construct nets and funnels to capture prey. The larve of caddis flies are often used as fish baits. A diagram of *Macromena fastuosum*, a typical example of a Caddis fly, is exhibited to illustrate this Order.

Order DIPTERA.

(*Two-winged flies.*)

This Order includes forms with two transparent membranous wings behind which are a pair of small, club-shaped organs known as " halters " or " balancers " which are the modified hind wings. There is no distinct prothorax. The mouth parts are adapted for piercing or sucking. The metamorphosis is complete. The larvae are usually footless grubs or maggots with the head retracted and the pupae are either exposed with the limbs free or enclosed in a scaly case. Most of the Diptera are fairly small and dull coloured. None is truly social. Many are parasitic and many others are scavengers. Some are aquatic. Many are flower-hunting, while others are predators and blood-suckers. This Order includes the flies, gnats, mosquitoes, etc., many of which are notorious for their disease-transmitting property.

A few selected species of flies and mosquitoes, including enlarged models of the common House Fly (*Musca domestica*) (Fig. 53) and the *Anopheles* mosquito (Fig. 54) which transmits the malarial parasite are exhibited. Enlarged models of the mouth parts of the mosquito are also exhibited in a separate wall case.

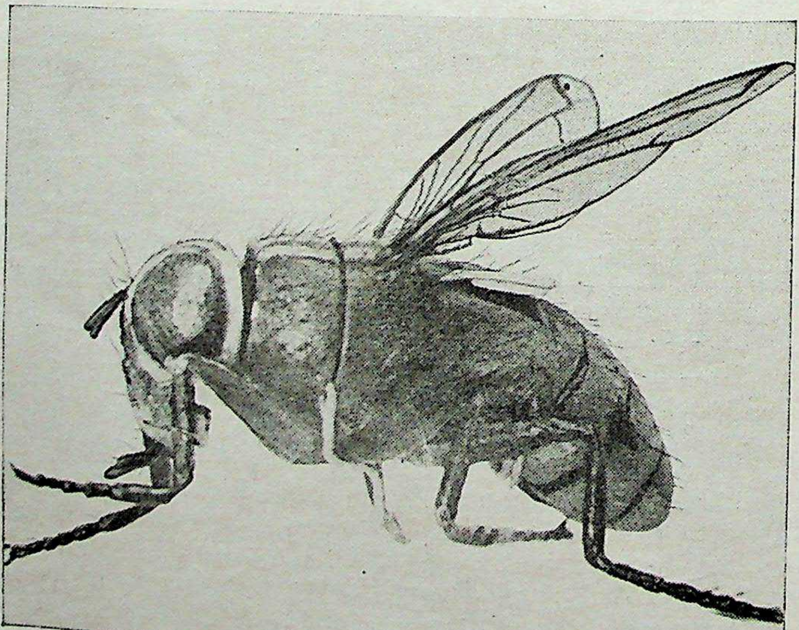

FIG. 53—ENLARGED MODEL OF THE HOUSE FLY.

Order SIPHONAPTERA.

(*Fleas.*)

This Order includes laterally compressed insects which are parasitic, feeding on the blood of vertebrates. The eyes are simple and the wings rudimentary. The skin is horny. The mouth parts are adapted for piercing and sucking. The antennae are short and stout and concealed in grooves. The legs are long, adapted for leaping. The eggs, laid amongst the hair of the host fall off and hatch into slender larvae. The larvae are minute and legless, and feed on organic debris. When full grown the larvae spin a dusky cocoon and there transform into a pupa. The adults avoid light and prefer the warmth of the fur or hair of its host. An enlarged diagram of the human flea (*Pulex irritans*) is exhibited to illustrate this group. The Indian Rat flea transmits the parasite that causes bubonic plague.

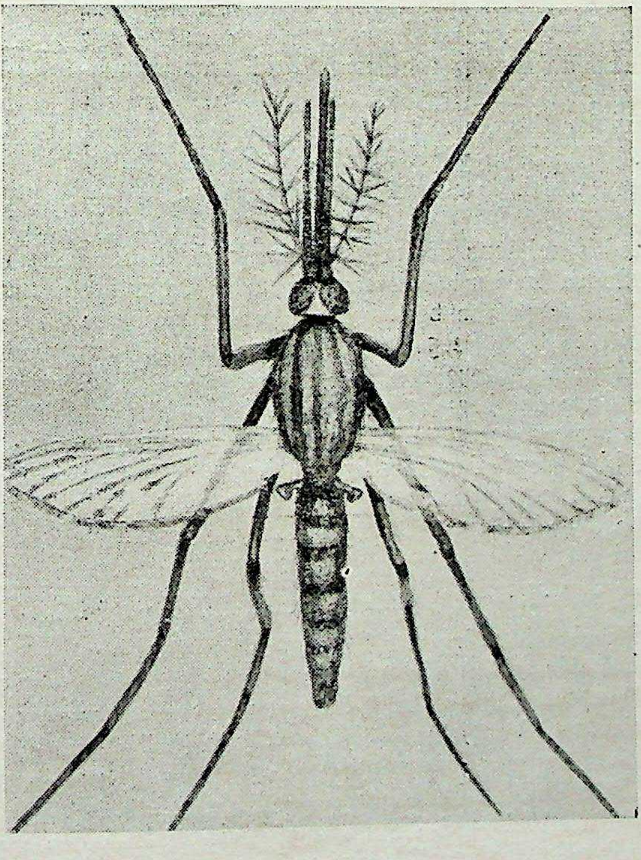

FIG. 54—ENLARGED MODEL OF THE MOSQUITO.

Order HYMENOPTERA.

(Wasps, ants, bees, etc.)

This Order includes ants, bees, wasps, saw flies and ichneumon flies. The members of this Order have two pairs of rather small wings which have no scales and are transparent and are interlocked in flight. The hinder pair of wings are smaller than the front pair. The mouth parts are of the chewing or chewing-lapping type. They have biting mandibles and the labium is adapted for sucking fluids. The abdomen may either be broadly attached to the thorax (as in the group *Sessiliventris*) or may be connected to the thorax by a narrow stalk or petiole (as in the group *Petiolata*). At the extreme end of the body of the female is either a saw, sting or ovipositor. The metamorphosis is complete and the pupa has its appendages free.

This is an enormous Order, comprising more than 100,000 described species. Judged from their intelligent behaviour, they must be regarded as the most highly developed members of the Class Insecta. Most species are solitary, but some, such as the Honey bee, some wasps and ants are social insects living in colonies and displaying remarkable differentiation into various castes and division of labour among them. Many of these social insects build elaborate nests. The larvae of many species are parasitic. The Honey bees are economically important as they yield honey which is commercially valuable.

Selected specimens of wasps, ants and bees belonging to common South Indian species and nests of a few species of wasps and bees including the bee-hive of the common bee, *Apis florea*, are exhibited. The Carpenter bee, one of our largest and most familiar Hymenopterous species, which makes large, round holes in trees and wooden beams, is also exhibited. Ants are all included in a single, very large family, the Formicidae, and most of them exhibit a high degree of intelligence and social organization.

Order STREPSIPTERA.

This Order includes minute insects with the mouth parts adapted for chewing, but small (or none). The males bear fan-shaped hind wings, but the forewings are reduced to club-shaped halters. The females are larva-like, without eyes, wings or legs. The females and larvae are permanently parasitic in the body spaces of bees, wasps, Homoptera, etc. They absorb nutriment from the host and modify the structure of the latter (i.e., "stylopize"). Enlarged diagrams of *Tridactylophagus mysorensis* (Male, *Pyrilloxena* sp. (female) and young larva of *Pentazocera australensis* are exhibited.

Order COLEOPTERA.

(*Beetles.*)

This large and important Order includes insects of carying sizes ranging from very minute forms such as the weevils, etc., to very large beetles attaining a length of nearly six inches in length (i.g., the Goliath Beetle of Africa). They are also very varied in their habit, being either herbivorous, predatory or scavengers, aquatic or terrestrial and with no social or parasitic habits. Their anterior wings, known as *elytra*, are hard, thick and leathery or brittle, and when not in use, completely cover in the functional hind wings which are thinner and membranous. Many forms are wingless, and in many others the elytra are small, so that the abdomen is exposed. The mouth parts are of the chewing type and are used for biting. The antennae are usually eleven-jointed. The metamorphosis is complete, the larvae being worm-like, with three pairs of legs and the pupae rarely encased in cocoons.

This Order in an enormously large one including numerous families comprising more than 280,000 species. It is therefore the largest Order in the Animal Kingdom.

Typical representatives, mostly of South Indian species, belonging to the following more important families are exhibited :—

Cicindelidae (Tiger beetles).—These are brightly coloured beetles which run actively in open places. The larvae live in damp burrows.

Carabidae (Ground beetles).—These are mostly blackish, long-legged, terrestrial beetles, carnivorous in habit.

Dytiscidae.—This family includes predaceous, aquatic insects with the hind legs adapted for swimming. The carnivorous water beetle, *Cybister limbatus*, with smooth black elytra and hairy, flattened hind limbs adapted for swimming, inhabiting our tanks and ponds, is a common example.

Coccinellidae (Lady bird beetles).—These are small, convex rounded, brightly coloured spotted beetles praying upon Aphide and Scale insects.

Dermestidae (Leather beetles).—These are small insects known as skin or leather beetles which attack furs, wollen dresses, meat, skins and hides and are highly destructive to museum specimens.

Lampyridae.—This family includes the Glow worms and Fire flies, with light-producing organs on the abdomen; they are nocturnal.

Buprestidae.—These are metallic coloured wood borers. The body is iridescent. The larvae have their prothorax flat and expanded.

Elateridae (Click beetles).—These are black, elongated beetles; the adults are hard, with a narrow body and can snap into the air with a click when placed on their back.

Lucanidae (Stag beetles).—The mandibles are enormous in the males. They burrow by digging into the ground. They attain a large size and their larvae live in roots or wood, underground.

Cerambycidae (Longicorn or Long-horned beetles).—These are large, robust, often brightly coloured beetles with very long antennae.

Scarabaeidae (Dung rollers or Lamellicorn beetles).—These are small to large sized beetles, with a broad, deep, convex body. The antennae are oval, clubbed, with closely folded plates. They are nocturnal. The larvae are white grubs feeding on grass, roots, etc. This family includes the familiar Rhinoceros beetle, *Oryctes rhinoceros* (Fig. 55) found throughout the cultivated plains where coconut palms are grown. These beetles are very destructive to young, growing palm trees.

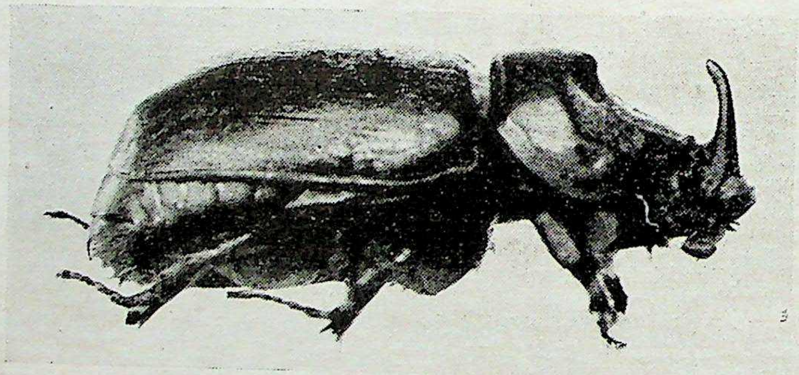

FIG. 55—ORYCTES RHINOCEROS: THE RHINOCEROS BEETLE.

Curculionidae (Weevils).—These are small to medium-sized beetles with a prolonged snout, many of them being very destructive to crops and stored products.

METAMORPHOSIS IN INSECTS.

One of the most characteristic features of insects is that they usually emerge from the eggs in the form of a worm known variously as larva, caterpillar, grub or maggot. The subsequent changes in its growth are known as metamorphosis. A few insects, however, emerge from the eggs in the form of miniature adults and these are known as "Ametabola". All other insects undergo metamorphosis and are known as "Metabola". The lower Orders among these undergo a simple metamorphosis, i.e., the young emerge from the eggs in an advanced stage of development and are termed "nymphs". Such insects are known as "Hemimetabola", while all other higher Orders are included under the group "Holometabola" and they undergo a complex metamorphosis often referred to as being direct or complete. Such insects (e.g., butterflies and moths) pass through a larval and a pupal (i.e., resting) phase before becoming the imago or adult.

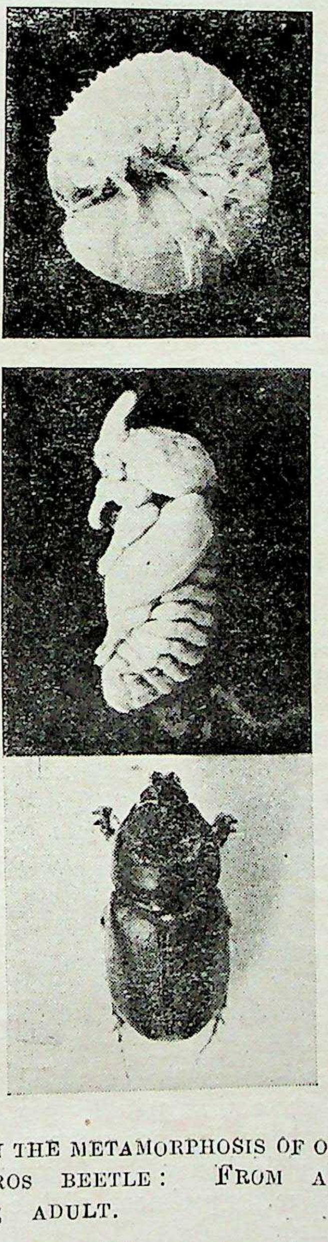

FIG. 56—STAGES IN THE METAMORPHOSIS OF ORYCTES RHINOCEROS; THE RHINOCEROS BEETLE: FROM ABOVE DOWNWARDS: LARVA; PUPA; ADULT.

Specimens showing the different stages in the life history of the Rhinoceros beetles (Fig. 56) and the Tussar silk moth are mounted and exhibited to illustrate complete metamorphosis in insects. The former is mounted as a wet-preserved exhibit in the section on Beetles in the systematic series and the latter as a dry-preserved exhibit in a wall case near the exhibits relating to silk. In addition, coloured illustrations of the life histories of a large number of species of butterflies and moths are exhibited on the wall on either side of the Insect Introductory Case near the commencement of the Insect Section in this gallery.

INSECTS IN RELATION TO MAN.

Economically, insects are the most important group of animals, next to the mammals, birds and fishes. Their activities affect man daily, either from the nature and extent of their injuries to the economically valuable plants, or to the domestic animals, or to stored products, or from the part they play in the economy of nature, in fertilizing flowers, in scavenging and cleaning the earth, in rendering waste matter available in plant food, in preserving the conditions of the soil and in providing food for birds and reptiles. The study of incests and their life histories, therefore, is a very vital one, especially in view of the immense damage they are capable of causing to some of our food and fibre crops.

The insects which are economically important, may be broadly classified as (1) Harmful insects and (2) Beneficial insects.

HARMFUL INSECTS.

Among others, harmful insects include a large number of pests of crops. A few such crop pests common in South India are exhibited in this gallery with labels indicating the names of the host plants they infest. A large number of insects, either in their larvel or adult stages, attack valuable crop plants such as paddy, pulses, oil seeds, vegetables, cotton and sugarcane and cause considerable damage which results in enormous losses to the country. Selected specimens of a few such pests commonly found infesting crops in South India are exhibited in a series of glass-topped boxes classified and arranged with reference to their host plants. Various methods, chemical, mechanical as well as biological, have been devised to control these pests. Besides these, harmful insects include also disease-carrying forms such as the housefly and the mosquito, enlarged models of which are exhibited in the regular systematic series in this Section.

BENEFICIAL INSECTS.

The most important among the beneficial insects are the productive insects, i.e., those that actually produce something that is useful to man, such as the honey bees, silk-worms and lac insects. Honey bees yield honey and beeswax—both articles of immense economic value. Specimens of bee-hive (Fig. 57) and honey bees are exhibited.

Silk is another very valuable commercial product obtained from insects. The silkworms are the caterpillars of different species of silk moths. In India, the usual silk of commerce is produced by the Mulberry silk moth (*Bombyx moi*); but the Tussar silk moth (*Antheria paphia*) and the Eri silk moth (*Attacus ricini*) also produce silk, but of somewhat inferior quality. Specimens of the adult moths of these species, and several specimens of the cocoons of the silk moths, samples of silk thread, both dyed and undyed, silk cloth, a silk carpet, etc., from Chennapatna, Mysore, and other localities are exhibited. The silk of commerce is the thread employed by certain silk moth caterpillars for the formation of their cocoons. It is formed in the body of the insect as a fluid in the salivary gands. This fluid hardens in contact with air, forming fine threads, noted for their peculiar gloss, strength and resistant properties. The rearing of silk cocoons and the production of commercial silk from them is a flourishing industry in Bangalore, Mysore and certain other parts of South India.

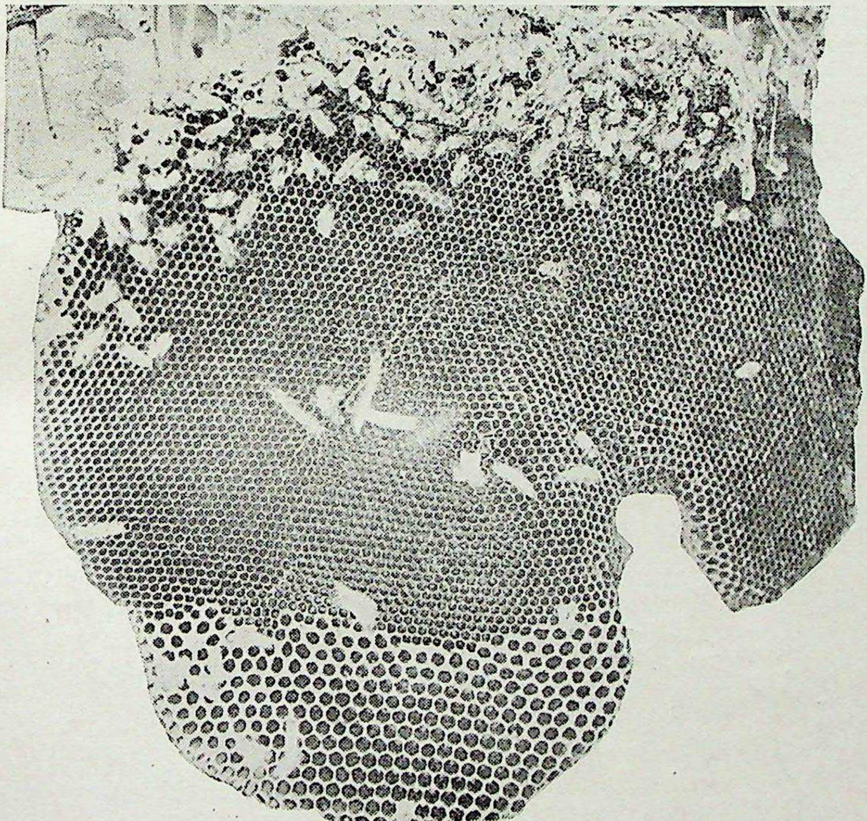

FIG. 57—HIVE OF THE SMALL INDIAN HONEY BEE: APIS FLOREA.

Next to honey and silk, the most important product yielded by insects is lac, which is used for various purposes, especially as an ingredient of the useful substance "shellac". Lac is the resinuous substance produced by a kind of scale insect, called the

Lac insect (*Tachardia lacca* or *Laccifer lacca*). A number of different varieties of lac products are exhibited adjacent to the cases containing silk exhibits.

NESTS OF INSECTS.

At the end of the Section devoted to insects in two separate show cases in the corner against the wall adjacent to the passage leading to the Fish Gallery, are exhibited a few selected specimens of insect nests to illustrate the nest-building habits of certain insects Among insects, it is naturally the social insects that rank foremost in the art of nest-building, as there is marked division of labour among them. The exhibits include a portion of the underground nest of the termites known as the "termitarium", the remarkable pot-like nest of the potter-wasp, the elaborate Hornet's nest with several horizontal combs of hexagonal cells (Fig. 58) the exquisite hive of the honey bees and the nest of the Carpenter bee made in the thick branch of a tree, and in a bamboo stem. The wood is riddled with neat, large, circular holes which the Carpenter bee has cut for itself; these holes lead into

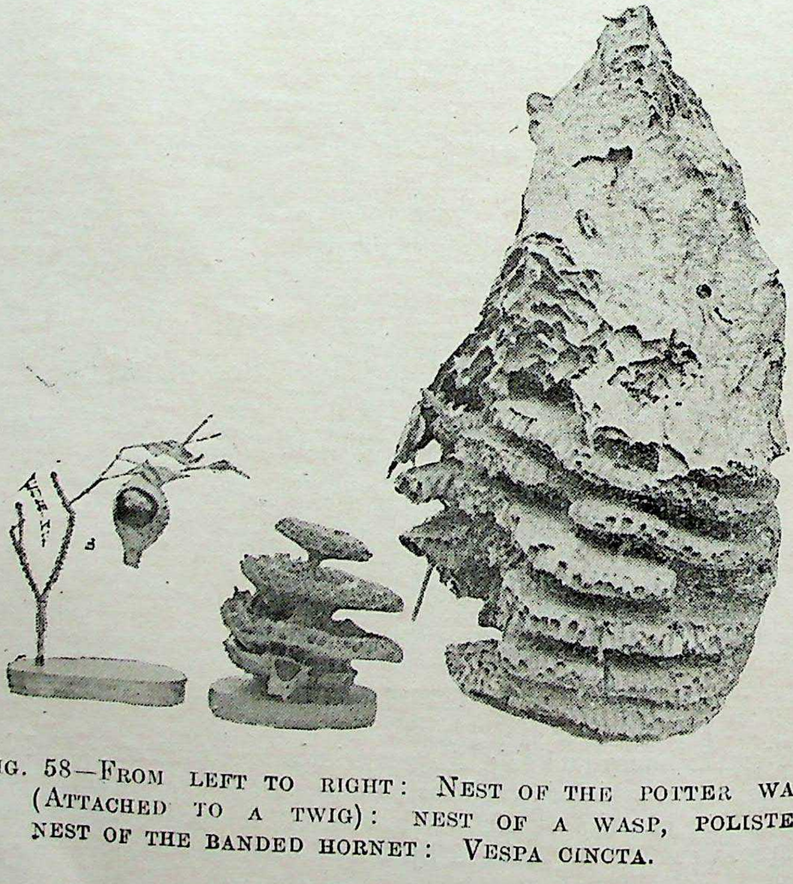

FIG. 58—FROM LEFT TO RIGHT: NEST OF THE POTTER WASP (ATTACHED TO A TWIG): NEST OF A WASP, POLISTES: NEST OF THE BANDED HORNET: VESPA CINCTA.

oblique tunnels which the bee divides into a series of chambers by means of horizontal partitions. The comb of the honey bee is also interesting in that there is a differentiation in the size of the cells. Some cells are small and intended as cradles for the worker grubs while others are slightly larger and are designed for the males or "drones". The "royal cells" intended for the production of the future queens are altogether different from these, being much larger, and of a different form, and project from the comb in a downward direction. The nest of a tree ant, *Crematogaster* sp. is also exhibited in an adjoining case (Fig. 59).

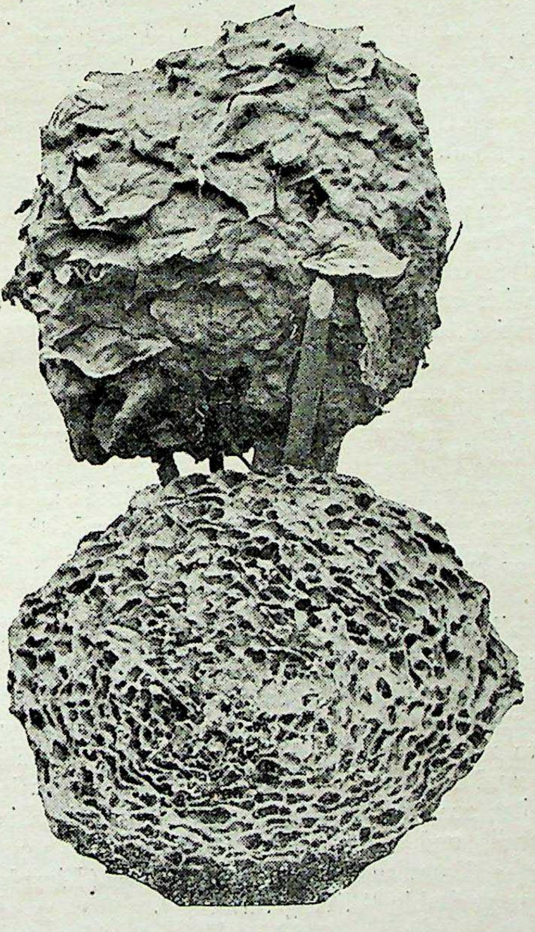

FIG. 59—NEST OF A TREE ANT: CREMATOGASTER SP.

Class ARACHNIDA.

The Arachnida include spiders, scorpions, pseudoscorpions, whip scorpions, mites and ticks, and the so-called "King Crab" which is marine and is superficially more like a crab. In some recent systems of classification, the King Crabs are treated as a separate Class, the Merostomata, and included, along with the Class Pyconognida (Sea spiders) and the Class Arachnida (comprising all the other Arachnids) in a Subphylum, (the Chelicerata) of the Arthropoda, but for the purposes of this Guide book, it is simpler and more convenient to follow Borrodaile who has included, in his latest text-book (1962 edition) all the above groups in the Class Arachnida.

The most characteristic feature of the Arachnida is the division of the body into two parts, an anterior *prosoma* and a posterior *opisthosoma*. The former is composed of the head and thorax united together and commonly called the *cephalothorax*, and the latter comprises the abdomen. Typically, there are six pairs of jointed appendages, and four pairs of legs, all on the cephalothorax. But there are no antennae or mandibles. The bases of one or more of the cephalothoracic appendages (except the first) are jaw-like and serve to compress and masticate the food. The mouth parts and digestive tract are mainly adapted for sucking. The abdomen (*opisthosoma*) is composed of twelve segments and is very variable. It may be with or without appendages and may retain its segmented character, or may appear unsegmented.

The Arachnida are mostly free-living, terrestrial animals of small size. Many mebers of this Class possesss poison glands and poison claws or " fangs " by means of which they kill insects and other small creatures and suck their body fluids as food. Spiders and a few other forms also possess special glands that secrete fine threads of silk which are used for building nests, egg cases, etc.

Economically, the Arachnida are not an important Class. However, some spiders and other forms may be actually beneficial to man because they prey upon various injurious insect pests. But a few spiders, and scorpions, have poisonous stings which may even prove fatal to man. Some mites and ticks are parasitic on man and animals and may produce severe illness or death, and many species of mites are injurious to plants. This Class is well represented as fossils and is of very ancient origin, some primitive members of the Class, such as the King Crab (*Limulus*) surviving even to-day as veritable " living forssils ".

The Arachnida are divided into a number of distinct and easily recognizable Orders, and specimens of some typical representatives of most of the major Orders of Arachnida are exhibited in this gallery, mostly as wet-preserved specimens in jars, supplemented by explanatory diagrams, photographs and descriptive labels outlining their chief features and habits. These principal groups are described briefly below in the order in which they are exhibited.

Order XIPHOSURA.

(*The King Crabs.*)

This group was well represented in the ancient Cambrian rocks, and numerous fossil forms are known, but to-day, only four species have survived. Of these, one is found along the coasts of India. The King Crab is the sole living marine representative of the Class Arachnida. Its body consists of a front part (*prosoma*) covered over by a shiny, dark brown, dome-like unsegmented carapace which is convex and horse-shoe-shaped and joined behind to the broad, hexagonal abdomen with a spike-like terminal appendage (*telson*) projecting backwards. The abdomen bears six pairs of broad, thin appendages joined along the middle line. The abdomen is moveably articulated with the prosoma. The appendages of the King Crab can be seen only when the animal is turned over on its back, for they lie wholly within the cavity formed by the sloping sides of the basin-like carapace.

The King Crab inhabits comparatively shallow waters along the coastal areas. It can burrow in soft sand by shoving its carapace into the sand and using its telson and other appendages to push itself along forwards. It also uses its telson as a means of righting itself when it happens to fall on its back. It is mostly active by night and feeds on Polychaet worms and molluscs which are grasped by the pincer-like front segments and masticated by the jaw-like hard bases of the other cephalothoracic appendages. King Crabs breed during early summer. Fertilization is external and groups of small eggs are deposited in shallow depressions in the sand between tide marks.

The Xiphosura show marked discontinuous distribution, one species being found along the East coast of North America, another along the shores of India, and two other species being represented in the Indo-Malayan Archipelago and along the East coast of China.

The single, wet-preserved specimen of the King Crab exhibited belongs to the sole Indian species *Limulus rotundicaudata* (Latreille), (Fig. 60 and 61) and was collected from the mouth of the Hooghly River in West Bengal.

Order SCORPIONIDA (= SCORPIONES).

(*Scorpions*).

In scorpions, the body is elongate, with a compact cephallothorax, and a narrow, elongated, abdomen, broadly joined to the front part (*prosoma*). The second pair of cephalothoracic appendages (*pedipalps*) are large and powerful with stout, pincer-like joints at its tips. The abdomen is long, composed of 12 ring-like segments. The last six segments are narrow, with a sharp, poison claw bearing the sting at its end.

Scorpions are nocturnal creatures, hiding by day and coming out at night to hunt for the insects, etc., on which they feed. These are seized with the stout, pincer-like claws of the pedipalps and when sufficiently large, they are killed by the sting. Many scorpions live in burrows which they dig with the aid of their legs. Scorpions inhabit mostly the warm tropical regions. They are viviparous, bringing forth their young ones alive. At first they are soft and white and climb on to the back of their mother where they first remain without food till their first moult, after which their skin is harder and darker and they begin to fend for themselves. An exhibit of a female scorpion carrying numerous young

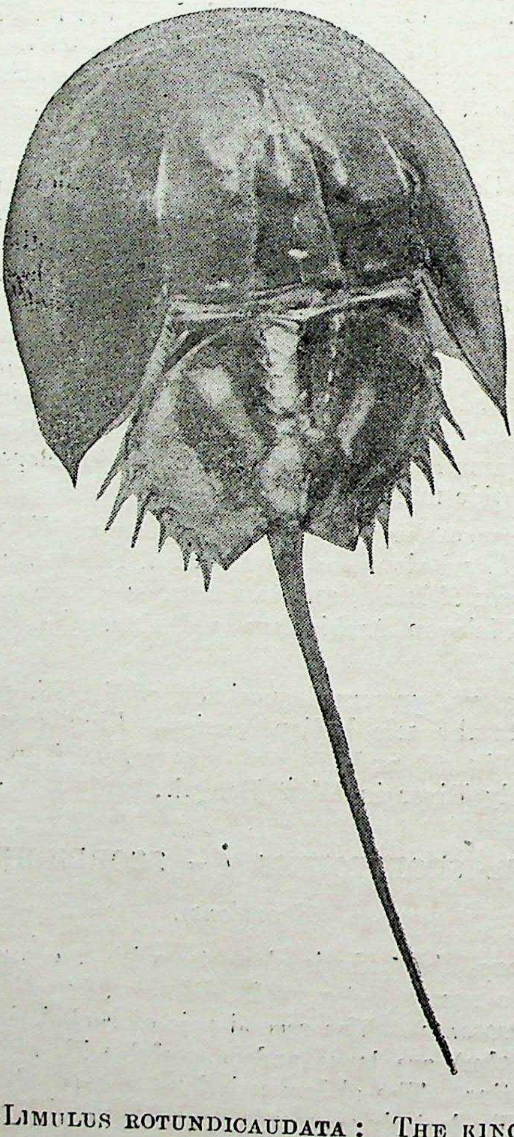

FIG. 60.—LIMULUS ROTUNDICAUDATA : THE KING CRAB : (DORSAL VIEW).

ones on its back is displayed as a wet mount to illustrate parental care in scorpions. Some of the young ones are isolated and mounted below to show clearly their comparatively minute size and yet their perfection of development when they are born.

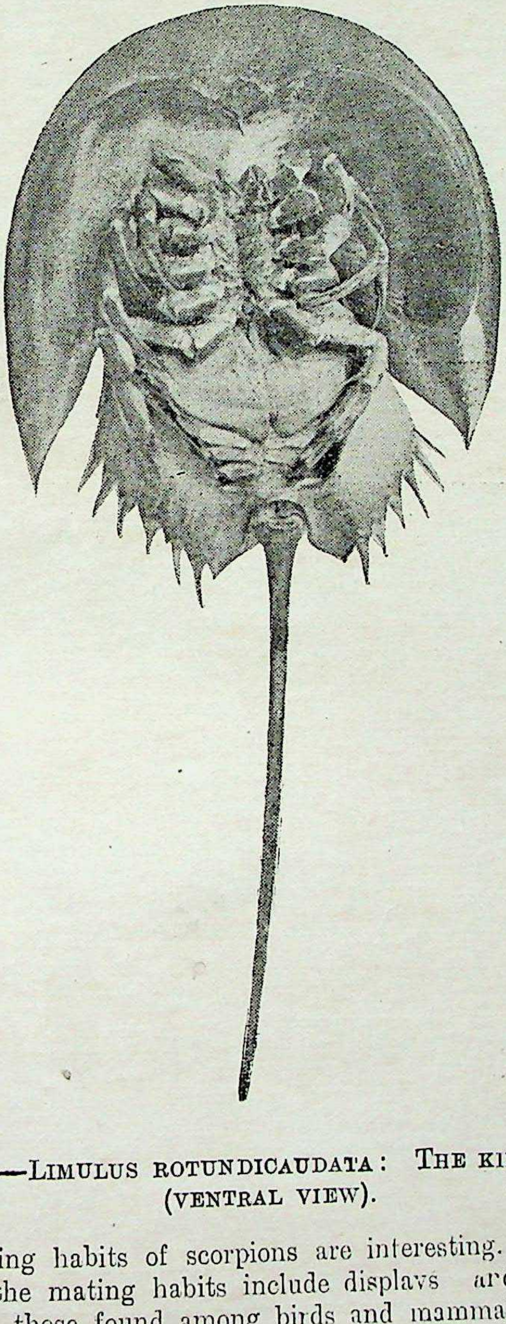

FIG. 61—LIMULUS ROTUNDICAUDATA: THE KING CRAB: (VENTRAL VIEW).

The mating habits of scorpions are interesting. In many Arachnids, the mating habits include displays and "dances" analagous to those found among birds and mammals. Scorpions have been observed to stand face to face with raised tails, which they intertwine and later move about together, the male going backwards and holding in his hands those of the female who follows him. An illustration showing the mating "dance" of scorpions is exhibited along with the mounted specimens.

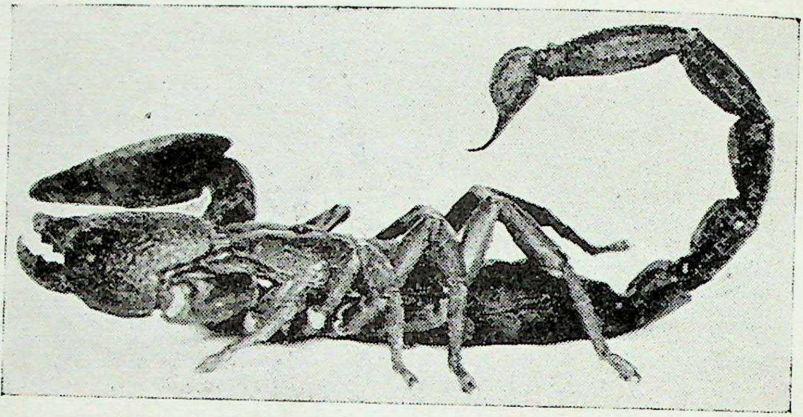

FIG. 62—PALAMNAEUS SWAMMERDAMI: THE GREAT BLACK SCORPION: (SIDE VIEW).

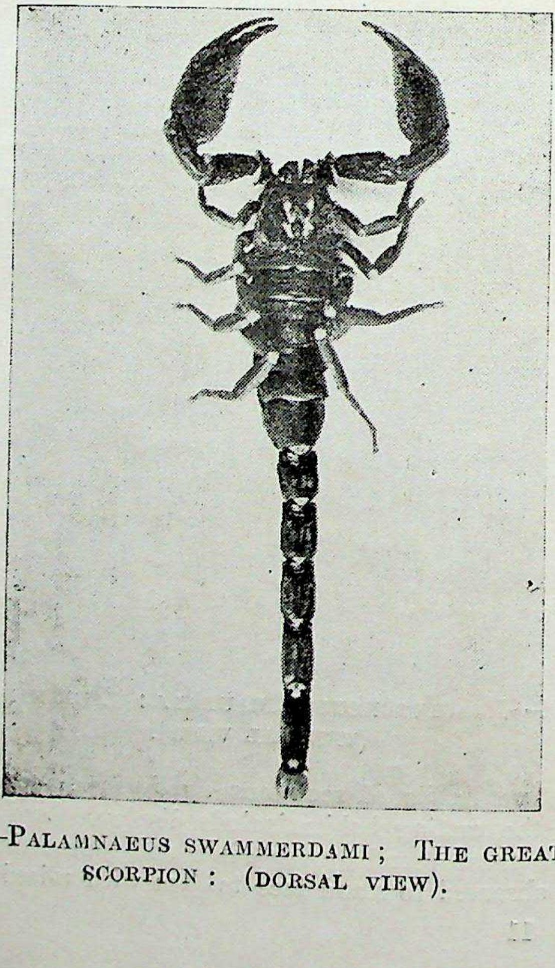

FIG. 63—PALAMNAEUS SWAMMERDAMI; THE GREAT BLACK SCORPION: (DORSAL VIEW).

Several wet-preserved specimens of common South Indian species of scorpions belonging to the genera *Isometrus*, *Lychas*, *Buthus* and *Palamnaeus* are exhibited. *Palamnaeus swammerdami* is the Great Black Scorpion (Fig. 52 and 63) which is the largest scorpion found in India, and with the exception of another West African species, it is the largest species in the world, sometimes reaching a length of seven inches. A dry-preserved specimen of the Great Black Scorpion is also exhibited *in situ* in its underground burrow which is shown in section in a small adjoining case. An interesting specimen is a freak scorpion with the posterior narrow part of the abdomen (*metasoma*) forked into two.

Order PEDIPALPI.

(*Whip scorpions and Scorpion spiders.*)

Whip scorpions (or Vinegaroons) and scorpion spiders resemble the true scorpions in their general habit, and to a certain extent, in their appearance, but they have no sting, and are provided with special organs for feeling their way about. As these organs are formed by a modification of the first of the four pairs of walking legs ordinarily found in Arachnids, only three pairs of these legs retain their usual form and function, but though the first pair comes to have sowewhat the form as well as the function of the antennae of an insect, their true nature is clearly shown by their position. In Scorpion spiders, especially in certain species that live in caves, they are extraordinarily long and slender.

In Whip scorpions, the cephalothorax is narrowly joined to the flat abdomen which is composed of 12 segments. This group is divided into two Suborders, namely, the Uropygi, in which the abdomen bears a slender, terminal, whip-like flagellum and the Amblypygi, in which the abdomen is without such a flagellum. Whip scorpions lack poison; they live in warm countries and are nocturnal in habit, preying on small insects.

The mating habits of Whip scorpions are illustrated by an explanatory diagram. In Whip scorpions, the courting male during the first part of the " dance " holds the antenniform first pair of legs of his mate in his hands and jaws, as the pair move along together. Later, the female raises her abdomen and the male strokes it with his antenniform legs.

Wet-preserved specimens of *Thelyphonus* (with a whip-like flagellum at the tip of the abdomen) and *Phrynichus* (Fig. 64) (without such a process on the abdomen) representing the two Suborders of this group, are exhibited.

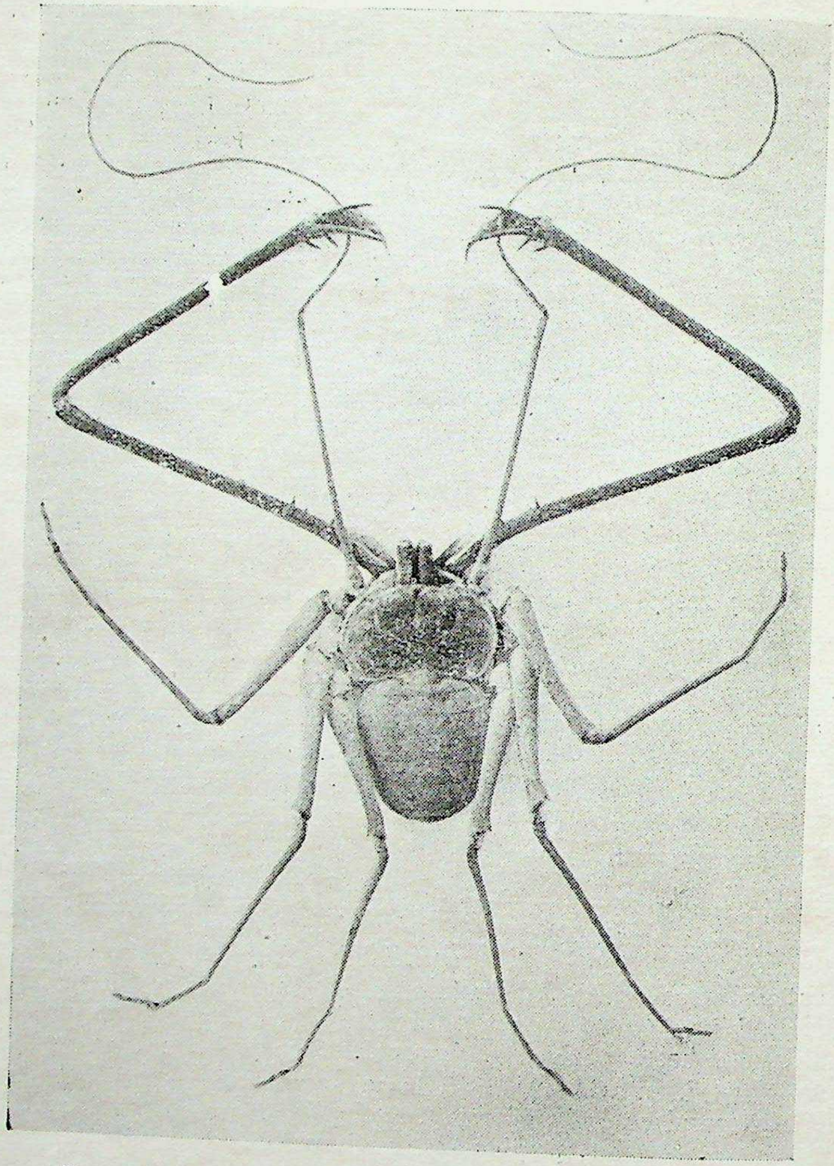

FIG. 64—PHRYNICHUS NIGRIMANUS: THE SCORPION SPIDER OR WHIP SCORPION.

Order ARANEAE.

(*Spiders*).

Spiders constitute a very large and familiar group of Arachnids, comprising more than 20,000 species. The body of a spider consists of a distinct cephalothorax and an abdomen, both rounded and unsegmented and joined by a slender waist. The abdomen bears tubercle-like spinnerets which secrete silk with which the spiders construct their webs. Spiders are free-living and solitary and are predaceous, feeding mainly on insects. They live in the most varied types of habitats ranging from the sea level to very high altitudes in the hills; they may occur on the sea shoe or in fresh-water swamps or among rocks in sandy soil or in dry deserts. Spiders generally entrap the prey in their webs and kill them with their poison.

Several specimens of the common South Indian species of spiders, including the common house spiders, the trap door spider, the giant Tarantula spider and the large wood spider, *Nephila maculata* are exhibited with ample descriptive labelling explaining their habits and other interesting features.

Trap door spiders.—Many of the smaller Mygalomorph spiders live in slik-lined burroys or shelters skilfully protected against intruders by a trap door. Some of the related species from open burrows, the entrance of which is surrounded by a raised rim composed of particles of soil fastened together with silk. The trap door, which seems to be a development of this rim, may be completely absent, or take the form of a thin, large, rounded flap lying over the entrance. This is known as the 'wafer' type of trap door. The spider usually waits till a suitable victim passes when the trap door is pushed up and the victim dragged in almost instantaneously.

The 'cork' type of trap door differs from the 'wafer' type in being thickened sufficiently to be rigid, the inner surface being slightly convex so that its edges may fit tightly into the mouth of the burrow, like a cork in the mouth of a bottle. The spider usually holds so firmly on to this type of trap door as to make it very difficult to force open, and only retreats under the greatest provocation.

It is very difficult to detect these types of trap door as they resemble the surrounding ground very closely. Some species make short burrows with two openings, one at each end, each closed by a trap door. One Madras species lives in hollows on old walls, etc., which it lines with silk and covers with two semi-circular trap doors hinged together. In the Nilgiris, there is a species which makes a forked burrow with one trap door at the entrance and another at the fork. When an enemy forces the outer door the spider shuts itself into one of the two limbs of the fork, so that without very careful examination, the remaining part appears to be a complete and disused burrow. Some species of trap door spiders are said to leave their burrows at night, when they spin a temporary web for capturing insects. Many spiders leave the burrows only accidentally or in search of a mate.

If the trap door spider is placed on the surface of the soil suitable for burrowing, it has no idea how to begin. But if placed in a hole in the same soil, it will quickly enlarge and develop it into a silk-lined burrow with a trap door.

A wet-preserved specimen of the Common Madras trap door spider, *Idiops constructor*, belonging to the family Ctenizidae, together with its burrow and trap door, and a series of four enlarged photographs to illustrate the mode of capture of its prey by the trap door spider are exhibited.

Tarantulas.—The term Tarantula refers, strictly, speaking, to an Italian species of Wolf Spider (family Lycosidae), but is commonly used for any exceptionally large, spider-like creature. The Suborder Mygalomorphae, to which the largest known spiders belong, has come to be associated with the Tarantulas (Giant spiders).

Some of these spiders are large enough to attack and eat small birds or even a small rat, after killing them with the poison contained in their fangs. Their poison is known to be capable of causing intense pain even to man.

Most Tarantulas live in burrows which they line with silk, but the genus *Poecilotheria* to which the specimens exhibited belong, lives in trees. Members of this genus and also of some others often emit a hissing sound when alarmed They produce the sound by rubbing certain spines situated on the surface of the basal joint of the fang against others situated on the contiguous surface of the basal joint of the palp.

A large, wet-preserved specimen of *Poecilotheria metallica* (family Theraphosidae) from Adyar, is exhibited (Fig. 65). Its body is more than 50 millimetres in length. It lives in trees or in the thatched roofs of houses.

Hunting Spiders.—These are included in the family Lycosidae. The carapace is narrow in front. The mandible is powerful, but not elongate. The legs are spiny and the abdomen is oval, rarely elongate. The males of many hunting spiders have their front legs or palps partly or wholly black or silvery white, making them very striking in comparison with the browner tints of the rest of the body. The appendages are conspicuously displayed before the female during courtship. Two specimens of *Euprosthenops ellioti* from Kambakkam Hill, Chingleput district, are exhibited to represent this family.

Jumping Spiders.—Jumping spiders belong to the family Attidae. They have enormously large eyes and have a very keen vision. Among the males of this family different parts are specially conspicuous in different species. The attitudes adopted in courtship are such as to display such parts to the best advantage, whether they be the crested head, the fringed palpi and forelegs, or the iridescent abdomen.

Mimicry among Spiders.—Many species of the family Attidae, and some of other families such as Cluboinidae and Thomisidae closely resemble certain species of ants among which they live, the first pair of legs being raised to resemble antennae. Close as this mimicry often is in form and colour, it is commonly still closer in attitude and movement. It is particularly striking in the case of the Attidae, as members of this family normally have a very different form of body and movement.

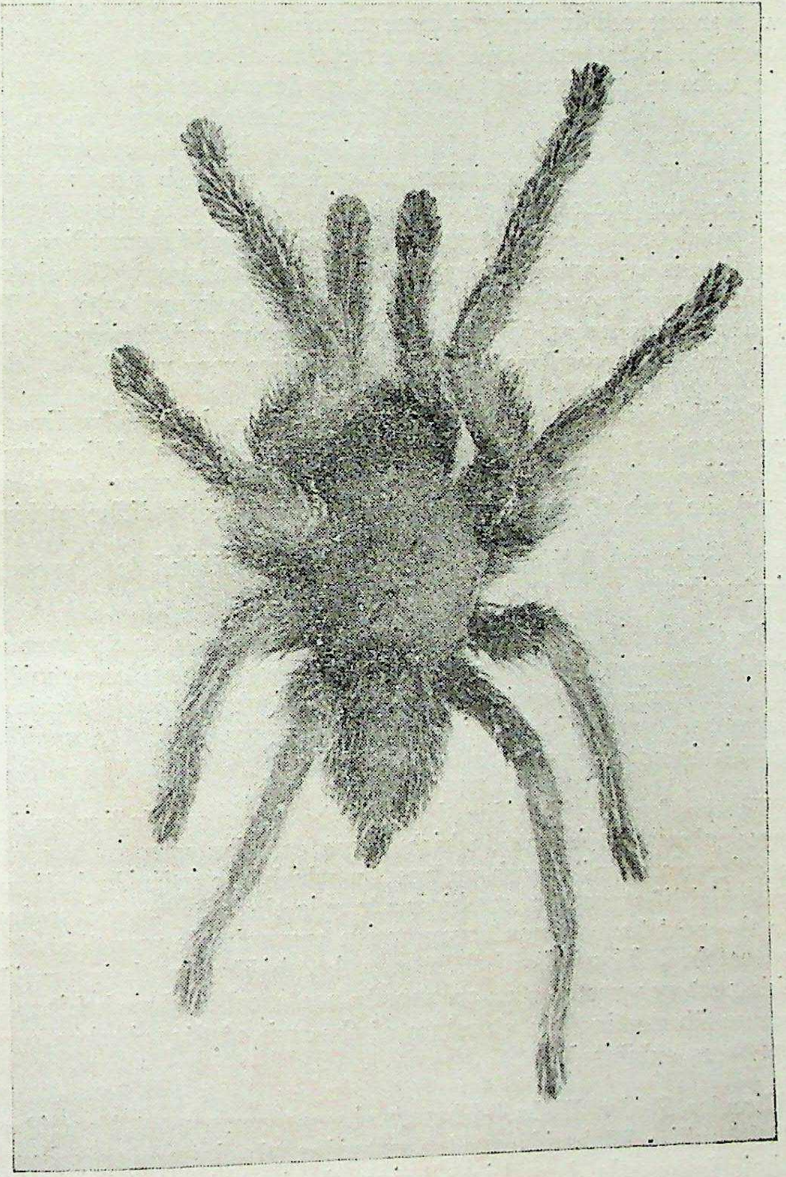

FIG. 65—POECILOTHERIA METALLICA: THE TARANTULA SPIDER.

Ants are protected by powerful jaws, painful stings and irritating odours, and are little liable to attack. Spiders, on the other hand, are extensively hunted and killed, particularly by certain wasps. Ant-mimicking spiders therefore derive considerable protection from their mimicry. In many cases also these spiders hunt and devour stray individuals of the ants they mimic and thus find a plentiful food supply always ready at hand.

Common House Spiders.—Spiders generally are very helpful in destroying insect pests, but though possessing poison fangs, very few ever succeed in biting a human being. Spiders are therefore good neighbours, and, with the exception of two or three which spin webs in inconvenient places, they deserve to be encouraged in houses. In Madras, there are five species of house spiders, out of which three spin webs. These belong to the families Oecobiidae and Pholcidae. The remaining two spin no webs, but make a neat nest for the protection of their eggs. One is the large, round, flat-bodied brown hunting spider of the family Heteropodiae, and the other is a jumping spider of the family Attidae, the female and young of which are brown, and the male black and white. The large one is a great destroyer of cockroaches and crickets, the small one, of mosquitoes. Both are therefore very useful.

Social Spiders.—Many species of spiders habitually live in groups and exhibit social behaviour. Many species of the family Uloboridae spin their individual webs in clusters often centering round the web of some larger spider of an entirely different kind.

A specimen of *Uloborus geniculatus* is exhibited to represent this family.

In the family Argyopidae, spiders of the genus *Cyrtophora* are usually found in groups, sometimes of great extent, each spider, however, having possession of its own particular web. A specimen of *Argyope anasuya* is exhibited to represent the family Argyopidae, but this is not, however, a social species.

To the family Eresidae belongs the common Indian spider, *Stegodyphus sarasinorum*, which forms colonies sometimes covering a large part of a bush or tree, in which the individuals live a true social life together, combining to spin their snares and to drag into the nest for common consumption any suitable prey that they may catch. Hundeds of them may be hidden in their untidy looking cobweb nests; they are mostly nocturnal in their habits. A diagram illustrating the structure of the web of *Stegodyphus sarasinorum* is exhibited.

Circular Spider Webs.—These webs are constructed by spiders of the families Uloboridae and Argyopidae, the latter, on account of their frequently large size, being the best known. They all have the same general plan, namely, that of a wheel, the spokes of which support a sticky spiral thread to capture the prey. Their geometrical precision is one of the greatest wonders of animal architecture.

They are supported on foundation lines and often spread between objects separated by a stream or other barrier across which the spider could not possibly walk. In such cases the spider first constructs a bridge of silk by letting a line from its spinnerers drift across on a current of air till it catches in something on the other side.

After securing and sufficiently strengthening its foundation lines, the spider constructs one diameter of the web, some point on which it makes the centre of the web, by running out a series of radii which are laid equidistant from each other by the spider fixing a definite number of paces along the foundation line from the last radius laid down, along which she has carried the new one from the centre outwards.

Next the radii are united by a spiral thread close round the centre, thus forming a strengthening hub. Beyond the hub a much more open temporary spiral is laid from within outwards, to help in supporting the spider while it lays its viscid spiral—the only sticky part of the web from without inwards cutting away the temporary spiral as it goes.

Certain kinds of spiders add patterns of while silk mixed with debris to their webs either to direct attention from, or to conceal, themselves.

The Giant Wood spider, *Nephila maculata* (family Argyopidae) of which a single, large, wet-preserved female specimen from Kambakkam Hill, Chingleput district, is exhibited (Fig. 66), spins such an immense web that it has to depart from the usual plan. Its radii, instead of all reaching the centre, are more numerous towards the circumference, in order to reduce the mesh of the network there to reasonable proportions without unduly crowding the centre.

Spiders of the genus *Cyrtophora* build a horizontal web of very fine silk with the mesh extremely fine and practically uniform from centre to circumference, raising the centre more or less definitely above the level of the circumference so that in some species the circular web comes to resemble a conical tent. A wet-preserved specimen of *Cyrtophora citricola*, from Velicheri, is exhibited to represent this genus.

Circular web-spinners often show a remarkable difference in size between the male and female, the latter, as is usual among the spiders, being the larger. An extreme case of this is found in the Giant Wood spider, *Nephila maculata*, in which the female is over a hundred times the bulk of the male.

Among the interesting web-spinning spiders, mention may be made of the large species, *Psechrus alticeps*, of which a large, wet-preserved specimen from Kodaikanal is exhibited. It belongs to the family Psechridae, which includes sedentary spiders spinning large, sheet-like webs.

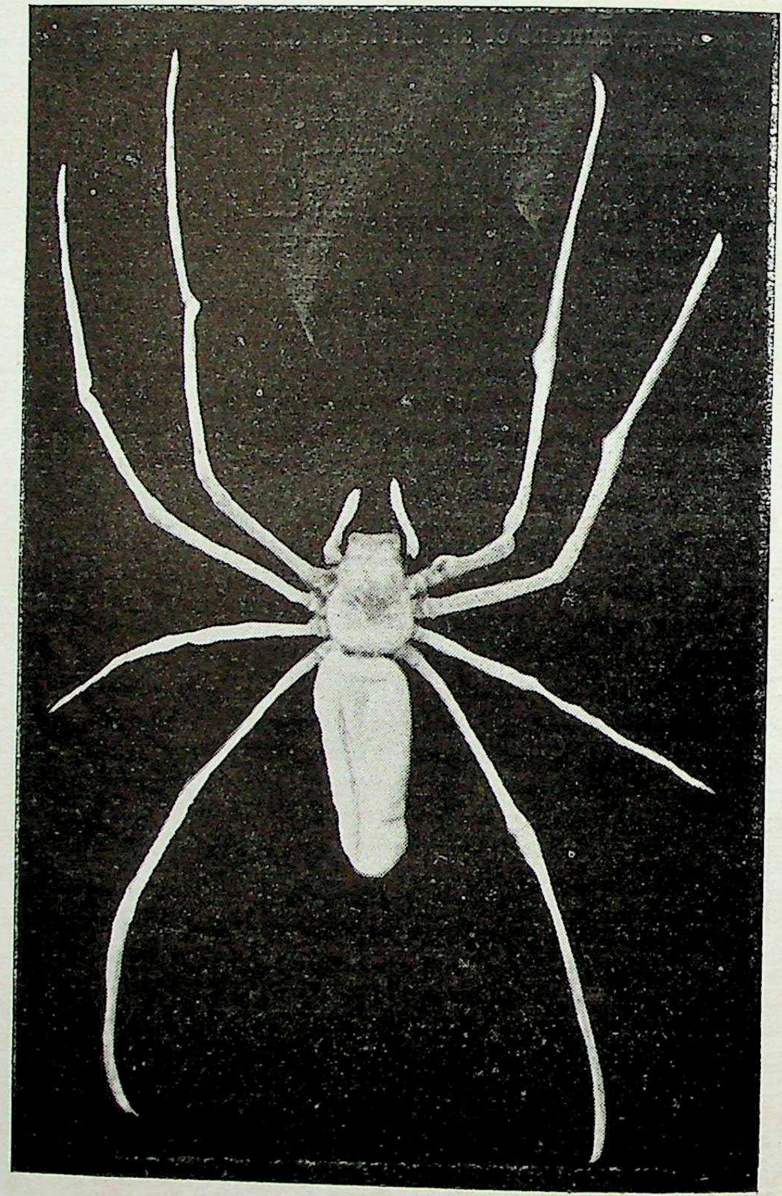

FIG. 66—NEPHILA MACULATA: THE GIANT WOOD SPIDER.

Order PALPIGRADI.

(*Micro-Whip Scorpions*).

Micro-whip scorpions are Arachnids of minute size, without eyes, resembling scorpions superficially, in their general shape and appearance. They bear a slender tail composed of 15 segments.

They seldom exceed 2 millimetres in length and are of a translucent whitish appearance. They are generally found living under stones. On account of their minute size, only an enlarged diagram of the typical species, *Koenenia mirabilis*, is exhibited to represent this Order.

Order SOLIFUGAE (= SOLPUGIDA).

(*Wolf Spiders or Sun Spiders*).

This Order comprises unusually hairy, spider-like Arachnids with conspicuous, swollen, two-jointed chelicerae with pincer-like chelae and joined to the carapace. The cephalothorax is composed of six segments of which the first to the third form a "head" bearing four or six eyes. The pedipalpi (2nd pair of appendages) are slender and leg-like and six-jointed; the first pair of legs is tactile and not locomotor in function. The abdomen is composed of six segments. There are no spinning organs. The Solifugae are confined to tropical or subtropical regions and are mostly found in dry, warm localities.

These Arachnids, popularly known as the Wolf Spiders or Sun Spiders, are remarkable for their wonderful agility. Though essentially desert forms, they also occur in forests, at least in India. They are nocturnal and strictly carnivorous. Some of the species dig holes in the ground, and the females at the breeding season live in burrows to protect themselves and their young ones. Wet-preserved specimens of *Rhagodes* sp. and of a species of the typical genus *Galeodes* (*Galeodes indicus*) in which the male has the head narrower than in the female, are exhibited as representatives of this Order.

Order PSEUDOSCORPIONIDA (=CHELONETHIDA).

(*False Scorpions*).

These are small Arachnids ranging in length from 1 millimetre to 7.5 millimetres, with a uniform, unsegmented cephalothorax broadly joined to the abdomen. They have not more than two pairs of lateral eyes, but eyes may sometimes be absent. There is no sting. They live mostly under moss or stones, in trees, or about buildings. They bear two glands which secrete silk with which they build nests. A single, small wet-preserved specimen of an unidentified species of false scorpion is exhibited.

Order PODOGONA (= RICINULEI).

These are small, obscure Arachnida of very restricted distribution, being found only in certain areas in tropical Central and South America and West Africa. Eyes are absent. There is a moveable hood on the cephalothorax over the small front pair of appendages (chelicerae). This is a rare group and only a comparatively few specimens have been collected so far. An enlarged diagram of the typical species of the genus *Cryptocellus* is exhibited to represent this Order.

Order PHALANGIDA (= OPILIONES).

(*Harvestmen or Harvesters*).

This Order includes Arachnids in which the body is short and ovoid with the cephalothorax uniform and broadly fused to the feebly segmented abdomen. They have two eyes and their legs are very long, slender and seven-joined. They possess stink glands on their cephalothorax but are devoid of silk glands. They are generally gregarious and are found in fields, woods and buildings, With their rotund bodies and long, ungainly legs they appear so odd that they have been aptly described as comedians among the Arachnida. A single wet-preserved specimen of a typical South Indian species, accompanied by an explanatory diagram, is exhibited.

Order ACARINA (= ACARI).

(*Mites and Ticks*).

These are small to microscopic Arachnids, with a compact, more or less ovoid body, with the cephalothorax and abdomen fused. There is no segmentation. The legs are widely separated. Their life history includes larval and nymph stages.

This Order includes a large number of different species of very varied habit. Many of them are extremely abundant, but most species are too small to be conspicuous or even visible to the naked eye. They live principally on fluids which they obtain from living on decaying animals and plants, and a number of species are well known as troublesome parasities. Of many of these species, however, the full life history is not yet known; even in the case of the comparatively large and conspicuous Red-velvet mite that appears in swarms after the rains in many places in India, the life history is not fully known.

Mites abound in soil, humus, stored foods, fresh and salt waters, and as parasites of both plants and animals. Some feed on fresh or decaying vegetable or animal matter while others suck the juices of plants, and still others feed on skin, blood or other tissues of land vertebrate animals. Ticks are mostly ectoparasitic on animals and feed on the blood of reptiles, birds and mammals.

Among important vegetable parasites belonging to this Order, the so-called 'Red Spider' may be mentioned. The common human skin disease known as Scabies or Itch is also caused by a mite, *Sarcoptes scabei*, the Itch mite of man, an enlarged illustration of which is exhibited. The largest parasitic members of the Order are the ticks which infest mostly dogs and other domestic animals, but are equally abundant on wild animals as well. Some ticks transmit disease from one animal to another, and mites are believed to aid in the spread of virus diseases among plants.

Wet-preserved specimens of the ticks *Margaropus annulatus* and *Hyalomma aequiptium* from cattle are exhibited as typical common South Indian representatives of this Order.

Class PYCNOGONIDA (= PANTOPODA).

(*Sea Spiders*).

These are not Arachnids in the strict sense, and are included in a separate Class. They are marine, spider-like creatures, but remotely related to other Arthropods. The body is small, with four (rarely five or six) pairs of legs, the mouth being borne at the end of a slender proboscis. They occur in the shallow waters along the coasts, mostly attached to sea weeds, etc., and also in deeper waters up to a depth of 12,000 feet. They feed on fluids and soft parts of hydroids. A single wet-preserved specimen of *Anoplodactylus investigatoris*, which is a typical Pycnogonid commonly found on sea weeds and hydroids in Pamban is exhibited to represent this group.

Two aberrant groups, the Pentastomida and Tardigrada, which were formerly treated as an appendix to the Arachnida are now known to be quite unrelated to the Arachnida and are regarded as separate Subphyla. These are represented only by enlarged diagrams among the exhibited series of Arthropods in this gallery and for the sake of convenience these diagrams are displayed at the end of the Arachnid series in the same show case.

PENTASTOMIDA.

The Pentastomida (or Linguatulids) are degenerate, worm-like, unsegmented parasites living in the lungs and nasal cavities of vertebrates. They have two pairs of ventral hooks near the mouth serving for attachment. They are highly adapted for a parasitic existence. An enlarged diagram of *Porocephalus annulatus* is exhibited to represent this group.

TARDIGRADA.

These are popularly known as water bears or bear animalcules on account of their supposed superficial resemblance to a minute bear. They are minute creatures up to one millimetre in length with soft, unsegmented bodies and four pairs of short, stumpy, unjointed legs, each with two or four claws. Some live in damp moss, others in water. An enlarged diagram of a typical species, *Echiniscus testudo*, is exhibited to represent this curious group which is doubtfully included among the Arthropods.

APPENDIX

PRIMITIVE CHORDATES OR LOWER CHORDATES.

A few selected exhibits comprising enlarged models, a photograph and some wet-preserved specimens mounted in jars representing the three most primitive groups of the great Phylum Chordata (which includes all the rest of the Animal Kingdom other than the Invertebrates, namely, the three primitive groups mentioned above (Acrania) plus the true back-boned animals—the Craniata or the Vertebrates) are displayed in the right extreme corner at the farther end of the Gallery of Higher Invertebrates in a vertical wall case directly above, and attached to, the show cases containing insect nests, adjoining the passage on the right side leading from the Invertebrate Gallery to the Fish Gallery. These animals (i.e., belonging to the three primitive groups of Chordates here illustrated by models, photographs and specimens) possess either throughout or at some stage of their life history, a flexible rod—the notochord—which is the rudiment, or rather, the fore runner of the vertebral column. In the adults of the true vertebrate or back-boned animals this rod is replaced to a greater or lesser extent by the vertebral column, while in these Primitive Chordates, it either persists throughout life, or disappears after the larval stage.

Although these animals are not Invertebrates, and are, on the other hand, closely related to the Vertebrates, and indeed are classed with the Vertebrates under the general term Chordata, they are exhibited in this Gallery purely as a matter of convenience since they form an isolated and more or less intermediate group, but indicating at the same time, by their close proximity to the Fish Gallery that they are actually members of the greater group of Chordata, although of a comparatively low grade of organization. Since these animals are strictly species of Chordates, notes on these could not, with propriety, be included in the general body of the text in the present Guide Book which deals with the Invertebrates, and they have therefore been relegated to an Appendix.

These primitive members of the Chordata belong to the following three Subphyla:—

(1) Subphylum Cephalochordata—the Lancelets, (2) Subphylum Enteropneusta (=Hemichordata)—the Acorn worms, and (3) Subphylum Tunicata (=Urochordata)—the Sea squirts.

Subphylum CEPHALOCHORDATA.

This Subphylum includes the single genus *Amphioxus* (also known as *Branchiostama*). It is an important animal from the point of view of evolution as it is the ancestral form from which the rest of the Chordata are supposed to have been derived. It is a small, semi-transparent, colourless, segmented animal, with a tubular, dorsal nerve cord and a notochord persistent throuhgout life, and extending the full length of the animal. Its body is elongated and laterally compressed and pointed at each end and it attains at most a length of two inches. It is popularly known as the Lancelet. It is entirely marine and occurs at moderate depths, usually half buried in the sand. It possesses remarkable powers of moving in the sand, but it is also capable of swimming. The mouth, on the ventral surface near the front end of the boy, is surrounded by a number of delicate, ciliated processes, the oral cirri. Enlarged models of an entire specimen (side view, from the left side, X 12) and of a transverse section of the animal (X 25) with the various parts individually labelled, and an actual wet-preserved specimen of the Indian species, *Branchiostoma indicum*, are exhibited to represent this Phylum.

Subphylum ENTEROPNEUSTA (=HEMICHORDATA).

This is another remarkable group of primitive Chordates in which the body is divided into three regions, namely, the proboscis, the collar and the trunk. In the front part of the trunk, paired lateral apertures—the gill slits—are present. The Subphylum is divided into two Orders, of which, the larger and better known group—the Balanoglossida—alone is represented among the present exhibits. The Balanoglossida are elongated, worm-shaped, bilterally symmetrical animals which live in the sand or mud in the sea. The trunk bears numerous gill slits on either side in its front part, communicating with corresponding apertures in the wall of the pharynx. The most remarkable anatomical feature of these animals is the presence of an unpaired diverticulum projecting from the front part of the alimentray canal into the base of the proboscis. This small structure is the notochord. It is the presence of this notochord, together with a tubular central nervous system and paired branchial apertures that has settled the position of these worm-like animals indisputably among the Chordates, although low down in the scale.

The Balanoglossids are entirely a marine group, living in sand or mud in burrows, which are frequently U-shaped, and their presence may be usually recognized by the casts thrown up by these animals at the openings of their burrows on the surface. The adult Balanoglossids live buried in the sand and swallow large quantities of the sand for the sake of its organic content, effecting a casting of denatured sand in much the same way as many Polychaet worms do. The colour of these animals is usually yellow, red and orange; the hepatic region is often green. These creatures generally possess an unpleasant smell resembling that of iodoform. One species of *Balanoglossus* is commonly found in large numbers in certain localities on the sandy beach on Krusadai Island in the Gulf of Manaar.

A photograph of an enlarged model of *Dolichoglossus*—a typical genus of the group, and an actual, wet-preserved specimen of another common genus, *Balanoglossus*, from Krusadai Island, are exhibited. The natural size of the specimen of *Dolichoglossus* (depicted by the enlarged model in the photograph) is indicated by the small model on the right, shown in the same photograph.

Subphylum TUNICATA (=UROCHORDATA).

The Tunicata, or Ascidians, popularly known as the " Sea squirts " are entirely marine animals. They include both pelagic, free-swimming form and sessile, sedentary forms fixed to rocks or other objects on the sea bottom. Many of them live in colonies and most species reproduce asexually by budding. The animals are usually enclosed in a tunic or test which is largely composed of a substance similar to cellulose. They are extremely sluggish animals, being little better than bag-like receptacles, but equipped with an alimentary canal, blood vessels, nervous system and reproductive organs. There are both solitary and colonial species. The solitary forms have typically two openings in the tunic, one for drawing in water to be filtered for minute food particles, the other for discharging the waste after filtration. When disturbed, as, for instance, by touching, some species contract suddenly, squirting out some of the water filling their cavities—hence the popular name, " Sea squirts ". Colonial species are generally embedded in a common, communal, jelly-like tunic and the individuals are arranged in systems around common openings for discharging the waste products.

The adults of these animals bear no trace of the notochord or a tubular nerve cord which are among the most characteristic features of Chordates. The exact systematic position of these animals therefore remained unsettled for a long time and they were considered as Invertebrates and assigned to various Phyla by different early authors, until their life history and larval development were worked out, when it was discovered that their tailed larvae possessed a flexible rod—the notochord—and a dorsal tubular nerve cord. In the other two Subphyla of the primitive Chordates dealt with above (namely, the Cephalochordata and the Hemichordata) the notochord persists throughout life (although only as a small rudiment in the latter group), and is replaced to a greater or lesser extent by the vertebral column in the adult vertebrates, but in many Tunicates (though not all) it disappears completely before maturity. This settled once for all their actual systematic position as a primitive group of the Chordata showing the characteristic Chordate features in their larval stage only.

Wet-preserved specimens of *Rhabdocynthia pallida* from Tuticorin, *Ecteinascidia thurstoni* from Rameswaram and another unidentified species of *Ecteinascidia* from Pamban are exhibited to represent this Phylum.